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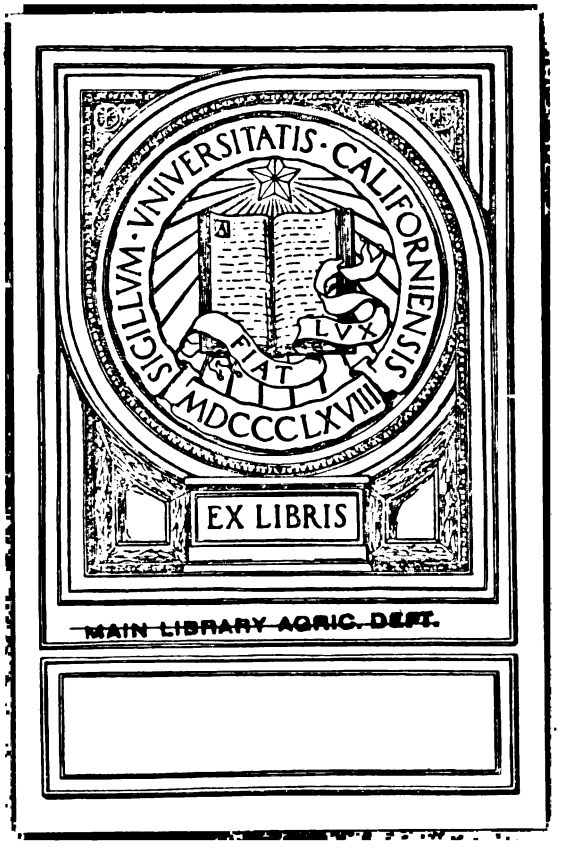

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CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE YEAR 1895.

Presented to both Houses of Parliament by Command of His Excellency the Governor.

1896.

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CONTENTS.

PAGE.

LETTER OF SUBMITTAL 1

WORK IN THE OFFICE 3
Correspondence and Publications, 3. Collection of Insects, 3. Rearing of Insects, 4.

WORK OUT OF THE OFFICE 4
Visits to Fruiting-growing Centres, 4. Demonstrations, 4.

BREEDING OF VEDALIA 5
Disappearance of Vedalia from Western Province, 5. Presence elsewhere in South Africa, 5. Difficulty in rearing Vedalia, 5. Australian Bug attacked by other lady-birds, 5.

BREEDING OF OTHER AUSTRALIAN LADY-BIRDS 6
Supposition of fruit-growers in regard to the value of imported lady-birds, 6. Attempt to introduce lady-birds from Australia, 6. *Rhizobius ventralis*, description and report d foods, 7. Success of colonisation, 8. *Orcus australasiæ*, description and reported foods, 8. Success of colonisation, 8. *Leis conformis*, description and reported foods, 8. Success of colonisation, 8. More lady-birds to come, 9.

AUSTRALIAN LADY-BIRDS IN CALIFORNIA 9
When introduced, 9. Success of, 9. Capacity of *Rhizobius ventralis* to multiply, 10.

POSSIBILITES OF AUSTRALIAN LADY-BIRDS IN CAPE COLONY 10
No comparison between Vedalia and other Australian lady-birds, 10. Conditions affecting the value of lady-birds, 11.

IMPORTATION OF INJURIOUS INSECTS 12
Some injurious species which have been imported, 12. Danger of importing others, 13.

INCREASED DESTRUCTIVENESS OF INTRODUCED SPECIES . . 13
Some examples of, 13. Reasons for increased destructiveness, 14.

LEGISLATION TO CHECK IMPORTATION AND SPREAD OF INJURIOUS INSECTS 14
No measure absolutely effectual, 14. Discussion of present regulations, 15. Attention of Board of Horticulture called to needed improvements, 15. Regulations of South Australia, 15.

RELATIONS OF INSECTS TO NATURAL ENEMIES 16
The natural balance in the insect world, 16. Explanations of, 16. Effect of man's interference, 17.

IMMENSE NUMBER OF INSECTS 17
Number reported on apple and oak, 18. Fecundity of insects, 18.

VORACITY AND DESTRUCTIVENESS OF INSECTS 19
What an insect consumes, 19. Losses through insects in Cape Colony, 20. In the United States, 20.

MEASURES TO CHECK LOSS THROUGH INSECTS 20
Clean culture, 20. High culture, 21. Rotation of crops, 22. Insecticides, 22. Necessity of a knowledge of insects, 23.

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PAGE.

NECESSITY OF STUDYING INSECT HABITS 24
Advantages of a knowledge of an insect's habits, 24. Codling Moth as an example, 25. Definition of Economic Entomolgy, 25. Climatic conditions affecting habits of insects, 26. Affecting success of insecticides, 26.

SOME REASONS FOR SLOW PROGRESS OF ECONOMIC ENTOMOLOGY IN CAPE COLONY 26
As regards collections of insects and libraries, 27. Variability of climate, 28. Travelling facilities to investigate insect attacks, 28. No spraying appliances or insecticides manufactured here, 28 Amount of Paris green used in America, 29.

PROGRESS IN USE OF INSECTICIDES IN CAPE COLONY .. 30
Work of energetic farmers during past year, 30. Indifference of Graaff-Reinet growers to Codling Moth, 30. Willingness of agricultural implement dealers to import spraying apparatus, 31. Opening for private parties to start a spraying business, 31.

REPORT ON INSECTS 32

PEACH MAGGOT 32
Life history, 32. Remedies, 33.

CODLING MOTH 33
A frightful pest, 33. Description, 34. Number of broods, 34. Remedies, 34.

PEAR SLUG 36
Occurrence, 36. Description, 36. Remedies, 36.

APPLE AND QUINCE BORER 37
Occurrence, 37. Description, 37. Remedies, 37.

AMERICAN BLIGHT 38
Other names, 38. Injury inflicted, 38. How spread, 39. Remedies, 39. Blight-proof stocks, 39.

ORANGE APHIS 40
Description, 40. Remedies, 40. Enemies, 40.

RED SCALE 41
Food-plants, 41. Description, 41. How spread, 41. Injuries caused, 41. Fumigation by hydrocyanic acid gas the best remedy, 42. Resin wash: formula, how prepared, and cost, 43. Paraffine emulsion: formula, and how prepared, 44. Little's Sheep Dip as a remedy, 45. Appliances for spraying: Galloway, Notus, Vermorel, and Nixon pumps, 45. Nozzles to use, 46.

BROWN OR SOFT SCALE 46
Injuries, 47. Description, 47. How spread, 47. Enemies, 47. Remedies, 47.

PEACH DIASPIS 48
Occurrence, 48. Description, 48. Injuries, 49. Food-plants, 49. Enemies, 49. Lime-sulphur-salt mixture: formula and how prepared, 50. Other remedies, 50.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1895.

Presented to both Houses of Parliament by Command of His Excellency the Governor.

1896.

REPORT OF THE GOVERNMENT ENTOMOLOGIST FOR THE YEAR 1895.

The Honourable the Secretary for Agriculture:

SIR,—I have the honour to present herewith a report on my work as Entomologist from the date of my arrival at the Cape, August 22nd, 1895, to the close of the year. Covering as it does the work and observations of but little over four months, this report is neither so full nor valuable as I hope to make its successors.

In submitting this report, I desire to render acknowledgment to Mr. L. O. Howard, Entomologist to the United States Department of Agriculture, for the kind determination of several insects and other favours, and to Miss E. A. Ormerod, late Consulting Entomologist of the Royal Agricultural Society of England, for several letters of encouragement and advice. Likewise, my thanks are due to Mr. L. Peringuey, Acting-Curator of the South African Museum, for the unreserved use of his private library and collections with those of the Museum under his charge, and for much invaluable entomological information, of which his extended residence in the Colony has made him the possessor. The insect collections at the Museum are well nigh indispensable to me as entomologist, and their distance from the Department building is much

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to be regretted. I also desire to thank the members of the Board of Horticulture for the aid they have afforded me in the execution of my duties, and the numerous correspondents, particularly Mr. Wm. Roe, of Graaff-Reinet, who have forwarded me specimens of insects and information of their attacks.

This being my first report, some mention may be expected of the policy which I intend to pursue in my work. In this regard, I beg to state that my intentions are to undertake the study of the principal injurious insects in turn, investigating their attacks, and as far as possible personally experimenting with measures for their prevention or destruction. My attention at first will largely be confined to those insects injurious to fruit trees, and elaborate experiments have been planned to prove the relative value of the best insecticides to cope with these pests in this climate. Later special attention will be paid to the pests of other crops. Those of mealies offer a particularly broad field of investigation. The results of all observations and experiments will be duly published in the *Agricultural Journal*, in the annual report or in special publications.

Respectfully submitted,

CHAS. P. LOUNSBURY,
Entomologist.

Cape Town,
February 18th, 1896.

REPORT OF ENTOMOLOGIST.

The work performed has been somewhat of a dual nature: first, attention to the inquiries of correspondents and routine duties connected with the office; and secondly, visits to the chief fruit-growing centres of the Western Province to become acquainted with the different districts and to learn from actual observation the condition of the country relative to injurious insects. A report will be made under these two headings, and then will follow reports on the rearing of beneficial insects, the discussion

of certain phases of economic entomology with relation to Cape Colony, and lastly, a preliminary report on the leading fruit pests of the country.

Work in the Office.

Correspondence and Publications.—Work in the office has occupied no inconsiderable portion of the time. From the first of September to the first of January, eighty-one inquiries relative to injurious insects have been received. Of these sixty-nine were answered direct to the correspondents and the remaining twelve through the medium of the *Agricultural Journal.* In addition to these, which were direct replies to questions, eighty other official letters were written. Six articles have been contributed to the *Agricultural Journal* and one to an outside paper. This last was a two-column article written for the *Worcester Standard* and was published in both English and Dutch. It enumerated, described and recommended remedies for such injurious fruit insects as were observed while on a visit to Worcester and vicinity. A circular of several pages in extent has also been issued. The purport of this circular was to obtain from viticulturalists all the information that is known to them concerning the Calandra Beetle (*Phlyctinus callosus*, Bohem.). This beetle is exceedingly injurious to many vineyards, and notwithstanding that its ravages extend over a period of more than a century and a quarter, no very satisfactory means for its destruction has come into general use. The almost total absence of the insect, however, in some vineyards following special treatments gives rise to the hope that comparatively easy means to destroy it do exist, and the circular is designed to get all the evidence possible on this point.

Collection of Insects.—Some time and attention has been devoted to the accumulation of a collection of insects for the Department. A collection is a very necessary adjunct to the office of a working entomologist and one should be located where it will be readily accessible to him. Heretofore, there has been no collection whatever in the possession of the Department, and the collections of the South African Museum are located too far distant from the Department building for convenient reference on all occasions.

Therefore, all insects received are carefully preserved as well as such as are collected while travelling about the country. These are named by comparison with the collections of the South African Museum. Specimens of the various species of destructive scale insects have been mounted on glass slides in preservative fluids for microscopic study. The slides thus far added to the collection, number above ninety.

Rearing of Insects.—Much more office time has been consumed in the care of living insects under study, and to the propagation of certain beneficial species. These are considered later.

Work out of the Office.

Visits to Fruit-Growing Centres.—Somewhat over one-third of the time was spent on work away from town. The greater part of this time was spent in visits to the fruit-growing centres of Wellington, Paarl, Stellenbosch, Constantia and Worcester. These were visited in the order mentioned and several days spent in each. The visits were made with the kind assistance of the local members of the Board of Horticulture. They enabled me to become acquainted with the leading fruit-growers, and to discover what injurious insects were most abundant; likewise what measures were being used for the extirpation of such insects and to judge what superior measures were applicable. A report on the insects which were found to be most destructive, with suggestions for legislation to counteract as far as possible the spreading of these insects to new localities and the introduction of other pests from abroad, has been submitted to the Board of Horticulture.

Demonstrations.—In connection with these visits, demonstrations in the preparation and application of a few of the most important insecticides were given at Wellington, Paarl and Stellenbosch. These were designed to encourage the parties witnessing them to spray their orchards. At each place the approximate costs of the ingredients necessary for the different insecticides were given and also the prices of different styles of pumps suited to applying the same. Two or three styles of knapsack spray-pumps were generally exhibited and explained.

Breeding of Vedalia.

During the past two or three years, the Australian Bug (*Icerya purchasi*, Mask.) has almost entirely disappeared in the Western Province. However, it still manifests itself to an injurious extent in a few portions of the Colony and in the other South African States; and a score or more of applications for colonies of the much famed *Vedalia cardinalis* have been received by the Department during the season.

Owing to the scarcity of the Australian Bug to feed it with, the rearing of Vedalia had been discontinued by Mr. C. D. Rudd, of Newlands, who had heretofore generously supplied a large number of applicants in all parts of South Africa; and for the same reason had been given up by the Department. Hence there was no source from which to supply applicants during the present season. But as some of the applications were urgent, I undertook early in November to establish a mother-colony of the lady-bird at the Constantia farm. To provide the colony with food it was necessary to breed the Australian Bug also, and a patch of Wattle grown in a great wire cage was infested with the Bug. Vedalia to start the colony was difficult to procure. The fact is, Vedalia has almost disappeared from the Cape Peninsula; and what little of the Australian Bug remains is held in check by other lady-birds, the principal one of which is a species of *Scymnus*. This beetle is slightly larger than the Vedalia. It is black with four red spots on each wing-case. Its larva bears a close resemblance to the Vedalia larva, but when full grown is larger and not of such a bright red colour. A number of the larvæ of these lady-birds was collected with what Vedalia could be found, and the cages stocked. The breeding of lady-birds in this manner cannot long be successful, as the food supply, limited as it must be to cage-grown food, will not long suffice when the beetles begin to breed rapidly. No beetles have as yet been taken from this source; but the most urgent of the applications have been filled by sending lady-birds bred in jars in the office and by a quantity collected by messengers.

Breeding of Other Australian Lady-Birds.

The remarkably successful results which followed the importation of *Vedalia cardinalis* to prey upon the Australian Bug (*Icerya purchasi*), has led horticulturists in this country and also in others to suppose that similarly successful results will follow the introduction of other lady-birds or predaceous enemies known to prey upon our imported injurious scale insects and aphides in their native homes. This supposition has taken strong hold upon the fancies of the fruit-growers in this Colony, and requests are constantly received for lady-birds to prey upon this or that scale.

To meet these requests, the Government took steps about six months ago to introduce into this country from Australia such other species of lady-birds as were credited with being especially beneficial in their native land. Mr. A. C. MacDonald, of the Agricultural Department, was then in Australia engaged in a study of the dairy industry, and to him the Government entrusted the commission of procuring colonies of desirable species. Mr. MacDonald secured the aid of Mr. C. Fuller, Assistant Entomologist of New South Wales; and these two gentlemen spent several days collecting the insects. Two small trees infested with scale insects upon which the beetles subsist were then secured. These were transplanted into large boxes enclosed in a framework covered with fine wire gauze. Within the cages thus formed, most of the beetles were transported; but to insure the chances of successful carriage a third lot was conveyed in a large glass jar, and were regularly supplied with scale-covered leaves taken from other small infested trees brought along for the purpose. In spite of all these precautions and the careful attention of Mr. MacDonald on the voyage, less than one-tenth of the beetles was alive when Cape Town was reached. The survivors were fifty *Orcus australasiæ*, thirty *Rhizobius ventralis*, seven *Leis conformis*, and one *Orcus chalybeus*.

The single *Orcus chalybeus* was a male and soon died. The *Orcus australasiæ* and the *Rhizobius ventralis* were at once liberated on a scale-infested tree in a glass house, built especially for the breeding of lady-birds, at Mr.

C. D. Rudd's estate, Fernwood, Newlands. Mr. Rudd was absent at the time, but the gardener of the estate, Mr. J. Wildsmith, kindly tendered the use of the building and generously offered to see that the insects were kept plentifully supplied with food. The beetles were placed in the building on October 6th, and I have visited them every two weeks since to note their condition.

Rhizobius ventralis, Er.—This is a black lady-bird measuring between one-eighth and three-sixteenths of an inch in length by about three-fourths as wide. The body above is covered with a fine light pubescence which gives the insect a grayish appearance. It is reported to be a general feeder upon scale insects, but to be particularly fond of Lecaninæ or soft scales. All that were liberated disappearedwithin a few days, and it was feared that they had died without propagating. Their small size, and the difficulty of finding them upon a tree badly infested with Brown Scale (*Lecanium hesperidum*) and almost covered with the black fungus that grows on an exudation from this insect, however, left some hopes that a few might be breeding on the tree unobserved, and these hopes received slight assurance on the 3rd of January of the present year when two of the beetles were observed and many of the Lecanium scales were found to have been attacked. The beetles must have belonged to a later brood since none of the old ones could have survived so long a time.

Orcus australasiæ, Boisd.—This species is much larger than *Rhizobius ventralis* and more showy. The beetles measure from three-sixteenths to one quarter of an inch in length and are nearly as broad. The colour is a bright, deep blue and the wing cases are marked with six reddish spots, four in a row across the front, and the other two behind, side by side. The principal food of the insect is said to be the Red Scale (*Aspidiotus aurantii*); of this there was considerable on the tree on which they were liberated, but to make the building more inviting to the beetles and to render the subsequent finding of the insects easier, a number of small infested trees in boxes were brought into the house. The work of the beetles was at once apparent, but one by one they died off, and in five weeks none were to be found. Early in December, however, a few small larvæ

were noticed, and on January 3rd, fully twenty full grown larvæ could be counted.*

Thus the chances now seem good for securing a permanent colony.

Leis conformis Boisd.—The *Leis conformis* is a slightly larger beetle than the *Orcus australasiæ*, being generally a quarter of an inch in length. It is yellow in colour and bears twenty-two black spots on the dorsal surface. As the beetles grow old the yellow gradually changes to red. Aphididæ or plant lice are their principal food. In Australia they are said to be very useful in destroying the Orange Aphis and the American Blight of the Apple, and are also said to attack the Australian Bug. As but seven were received, it was not deemed advisable to liberate them in a building until they multiplied. This they soon did and in six weeks, the seven had become seventy. The old beetles survived until late in November and curiously enough one laid a small batch of eggs at this late date. Over sixty of the second brood of beetles were taken to Fernwood on November 22nd, and placed in a building similar to that in which the other lady-birds were being reared. Here they were almost daily supplied with plenteous quantities of the common green aphis (*Siphonophora rosæ*) on cuttings of sweet pea vines. This food they ate with evident relish, but few showed any disposition to copulate and but one small cluster of eggs was laid. Fearing that the colony would be lost, Mr. Rudd had those seen in coitu placed on an orange tree infested with the Orange Aphis out-of-doors. As an additional precaution, a number were kept in confinement in glass jars at my office and fed in the same way as the first brood had been. The difficulty of procuring food for these was great as the season was far advanced and aphides scarce. A few eggs were laid and hatched; but the larvæ appeared weak and sickly and survived but a short time. The old beetles, too, in spite of care and change of food to aphides of different species, succumbed before the new year. Those at Fernwood fared no better and on January 3rd not a single living one in any stage could be found. There is

* Beetles were seen on February 1st.

some hope, however, that those which were liberated out-of-doors may have thrived. None of these have been seen since the last week of December, but the difficulty of finding a limited number in the open orchard is too great to state positively that they failed to breed.

More Lady-Birds to Come.—The endeavours of the Government to introduce beneficial lady-birds have not ended with this one attempt. A second consignment of *Orcus australasiæ*, carefully screened in on a boxed tree was sent by Mr. Fuller in charge of a passenger on the steamer which arrived here December 3rd. The condition of these when received was bitterly disappointing, all but one being dead. No more have since been received; but negotiations have been made with the Government of New South Wales for sendings of *Orcus chalybeus*, *Orcus australasiæ* and *Leis conformis* and colonies of these may now arrive on any steamer from Australia. The labour involved in collecting and forwarding these lady-birds is considerable, and if the efforts to colonize them here are finally successful, the people of this country will owe a debt of gratitude to the Government officials of New South Wales, especially to the Entomologist, Mr. A. Sydney Oliff, for their kind assistance.

Australian Lady-Birds in California.

All four of the species of lady-birds (*Orcus chalybeus*, *Orcus australasiæ*, *Rhizobius ventralis* and *Leis conformis*, at which attempts at colonization have been made in this country, were introduced into California early in the year 1892; and subsequently other and larger colonies were brought from Australia to re-inforce the first. Four seasons have now elapsed since the first were imported, but as yet the success of the beetles in the work for which they were introduced has not been marked. Of the four, *Rhizobius ventralis* has attracted the most attention. It was specially intended to destroy the Black Scale (*Lecanium oleæ*) which is exceedingly common and injurious in many parts of the State. In a few groves the scale is said to have been almost exterminated, but in most localities the lady-bird has proved a failure, and in Southern California, the horticultural papers have advised the fruit-growers to return to spraying and fumigation to clean their trees.

Rhizobius ventralis multiplies with much greater rapidity than any of the other three. Mr. Koebele, who was instrumental in introducing it into California, estimated that there were six broods a year, and that under favourable circumstances, a single female would in this time be the progenitor of 15,000,000,000 insects. With such prolificacy, it was confidently expected that the beetle would multiply sufficiently in two years to rid the country of the Black Scale as *Vedalia cardinalis* in a similar period had done with the Australian Bug. But even at the end of four years these expectations remain unfulfilled.

Possibilities of the Australian Lady-Birds in Cape Colony.

The Australian Bug is a native of Australia. In that country it is held in check by a number of enemies but chiefly by *Vedalia cardinalis*. The Australian Bug is very prolific, and when introduced into other countries without its natural enemies it spread with amazing quickness. The Vedalia also is an insect which breeds with surprising rapidity. It tears open the ovisac of the Australian Bug and devours in a few meals what if allowed to hatch would be a great host of destructive insects. When it was introduced into the Colony, it found an abundance of food and all conditions right for tremendous increase in numbers. Hence it soon overrun the country and reduced the Australian Bug to its normal state in nature. Every circumstance was in favour of the rapid subjugation of the Bug by the Vedalia—its feeding on the Bug alone, its short round of life and great prolificacy, and its very destructive method of attack.

Such a striking case of the value of an imported enemy of a destructive insect is entirely exceptional; and it is one which will be seldom or never repeated. A combination of such favouring conditions may never again present itself. Few comparisons can be drawn with the conditions surrounding any of the other lady-birds we are striving to colonize.

We hope to gain most from those attacking the Red Scale, *Orcus australasiæ* and *Orcus chalybeus*. The Red

Scale is an injurious insect in Australian orchards and artificial remedies are required to keep it in check there as well as here. It is not supposed to be a native of Australia, and the lady-birds which attack it there are simply native species which have taken to it. The Red Scale is an introduced pest in this country, also, and is preyed upon by native lady-birds, although none of these appear to be especially valuable. As neither *Orcus chalybeus* nor *Orcus australasiæ* are entirely effectual at home, it can hardly be expected that they will prove entirely effectual here, even if in their importation they are freed from some of the enemies which preyed upon them in Australia. At the best they are both slow to propagate and it would be many years before they became generally distributed over the Colony.

Mr. A. Koebele, the Californian agent who introduced these and the other species into California from Australia, predicted that under the most favourable circumstances the two species of *Orcus* would increase 2,500 fold in a year. This rate of multiplication is insignificant in comparison with that of *Vedalia cardinalis* or *Rhizobius ventralis*. Moreover the Orci have proved to be difficult to rear in confinement. Many billions of beetles may be bred in one year from a few *Vedalia cardinalis* and they breed readily in confinement.

Much the same conditions exist with regard to *Leis conformis* and the injurious insects which it preys upon. In Australia, this lady-bird is stated to prey unceasingly on the Orange Aphis (*Siphonophora citrifolii*, Ash.) and the American Blight (*Schizoneura lanigera*, Hausm.). Neither of these insects is indigenous to Australia, and in spite of the prevalence of *Leis conformis*, the American Blight at least has proved a scourge, and, prior to the adoption of blight-proof stocks for grafting, apple-growing, to judge from what is written on the subject, was more difficult in Australia than it is in Cape Colony.

The Orange Aphis, the other important insect upon which *Leis conformis* preys, is most injurious during the early spring. Before mid-summer, our native lady-birds have generally increased sufficiently to deal with it. If *Leis conformis* will come out of hibernation and attack the

aphides before our native species put in their spring appearance, it will be a valuable addition to our list of beneficial insects, but if it proves as slow as the native species, which from this season's observations I expect it is, the benefits which will follow its distribution will not be great.*

At the most, then, no very great advantages will be derived from the colonization of any or all of these four lady-birds. But as they cannot fail to accomplish some good and can possibly do no harm, their introduction is well worth the time and trouble being expended on it; and no effort will be spared to make their colonization a success.

Importation of Injurious Insects.

The injurious fruit insects discussed in the appended report are, with one possible exception, all imported pests. Such is also the case with many of the insects pestiferous to other agricultural products. We have the Bean Weevil (*Bruchus obtectus*, Say), an imported insect infesting stored beans; the Pea Weevil (*Bruchus pisi*, Linn.), injurious in much the same way to peas; the Grain Weevil (*Calandra granaria*, Linn.), infesting stored grain; the Diamond-back Moth (*Plutella cruciferarum*, Zell.) and the Cabbage Aphis (*Aphis brassicæ*, Linn.), both very destructive to cabbages. Of our injurious fruit insects, the scale insects are very important. Most if not all of these are introduced species. Some of the most common are the White Peach Scale (*Diaspis lanatus*, Morg. and Ckll.) which infests peach and allied fruits in the Western Province, the Red Scale (*Aspidiotus aurantii*, Mask.) and the Brown Scale (*Lecanium hesperidum*, Linn.), which are destructive to citrus trees throughout the Colony. The Long Scale (*Mytilaspis gloverii*, Pack.) and the Mussel Scale (*Mytilaspis citricola*, Pack.) are other imported citrus tree scales which, however, are not yet generally distributed. Among other orders of insects, the American Blight (*Schizoneura lanigera*, Hausm.) and the Codling Moth (*Carpocapsa pomonella*, Linn.), both of which are very destructive to the apple,

* In a letter dated December 18th, 1895, from the Under-Secretary for the Department of Mines and Agriculture of New South Wales, it is stated that *Leis conformis* is only common in that country in February at the same time as its host, the Peach Aphis.

should be mentioned as noxious importations. It is even exceedingly probable that the Peach Maggot (*Ceratitis citriperda*, Mac L.), which now occurs almost everywhere in Cape Colony where peaches are grown, is an imported pest.

Disregarding locusts, many other countries suffer much more severely from the attacks of insects than does Cape Colony; and in importing agricultural produce from these countries, we run great risks of introducing new pests. For instance, the Potato Tuber Worm (*Lita solonella*, Boisd.) might easily be brought among potatoes from Australia, and might in a few years prove a great difficulty to potato culture.* From such risks as these there is little escape. Every country is open to them, and thus far Cape Colony has fared remarkably well. With the development of the country, however, an increase in the number of pests and in their destructiveness is to be expected. Commerce with other countries and the importation of foreign fruits and vegetables are bound to increase, and with this increase of imported produce we will surely suffer from the incidental introduction of injurious insects.

Increased Destructiveness of Introduced Species.

It is a matter of common comment that the crops of the older countries, such as those of Europe, are not damaged to nearly the extent by insects as are the same crops in more recently settled countries as America, Australia, or this Colony. This condition is largely due to the fact that many of the pests in the old countries are imported into the new, and that these pests become far more injurious than they were at home.

Nearly all of the agricultural products originated in the older countries. These were introduced into the newer countries with the advent of civilization, and in the process of time most of the pests attacking these crops have followed. In this country, for instance, the American Blight and the Codling Moth have come on the Apple, the Red Scale and the Brown Scale on the Orange, and the Phylloxera on the Grape. These injurious insects become

* Since writing the above, I have heard that this insect has already been introduced into Cape Colony.

added to the native insects of the country; and thus in time the number of pests to a crop becomes greater in the new country than in the original home of the plant. This is now the case with many crops in the United States, and has earned for that country the reputation of being "the home of insects".

The increased destructiveness of imported insects is well known. Few insects in this country now command greater attention than the Phylloxera of the Vine (*Phylloxera vastatrix*, Planchon). In the Eastern United States, the original home of this insect, it is rarely heard of as injurious, but throughout those countries into which it has been unfortunately introduced, its terrible destructiveness under new and more favourable conditions has manifested tself. Another almost equally striking illustration in Cape Colony is the Australian Bug (*Icerya purchasi*, Mask.). In Australia its ravages are never very extensive, but its depredations in this country will not soon be forgotten.

The increased ravages of injurious insects in new countries result from the improved conditions under which they become placed. The relations which have existed, perhaps for centuries, between them and their food plants, their parasites and predaceous enemies such as other insects and birds, are all suddenly broken. In their importation their natural enemies which had previously preserved a balance between them and the vegetable world are all left behind, and they are free to "increase and multiply" without hindrance or molestation until native parasites and predaceous insects and animals acquire the habit of preying upon them. By the introduction of some of their enemies in the land from which they came, man can in exceptional cases do much towards counteracting their increase, but in the vast majority of cases generations are required before a proper balance becomes again established.

Legislation to check Importation and Spread of Injurious Insects.

Until very recently no country sought to guard itself against the introduction of foreign pests. No measure short of entire prohibition of commerce could be entirely

effective against all pests; but it is now a recognized fact that the importation of many can be greatly delayed and perhaps entirely prevented by economical measures. Most of the pests of fruit trees could be thus excluded since the majority of these pests reach us attached to nursery stock or fruit which admit of easy examination to discover the presence of insect enemies. This country has not been far behind others in protecting its fruit interests by the passage of wise regulations requiring the absence of disease and injurious insects on imported trees; and if carefully enforced, such laws as we now have are of great advantage to horticulturists. Nurserymen abroad, knowing that diseased or insect-infested stock will not be received into the Colony, must exercise greater care in selecting stock for the trade here.

The regulations now in force in the Colony are excellent in their way, and, I believe, are drafted on the proper lines. They are not prohibitive of the introduction of new fruits into the Colony, only demanding that such bring no new pest with them. However, they would be much more valuable if they demanded the absence of all pests, disregarding whether or not the pests already occurred in the country; and further, legislation is needed to prevent the spread of such insects as do become introduced. These facts have been brought to the attention of the Board of Horticulture and very likely the laws will be amended in the near future. To best check the spread of injurious insects within the Colony, it will be necessary to have all nurseries where stock is grown for sale registered and periodically inspected by some one competent to determine the presence of noxious insects and diseases, even when the infestation is very slight. This will be some labour and expense, but cannot fail to vastly decrease the dissemination of destructive insects.

It is interesting to observe how exceedingly stringent the laws of some other countries are on the subject of importing foreign fruit trees with the view of excluding injurious insects in comparison with those we have in Cape Colony. The laws of South Australia forbid the introduction of any growing plant by any person except by the Director of the Botanic Gardens without the written

consent of the Minister of Agriculture, which can only be obtained after recommendation by the Director of the Botanic Gardens; and require that such plants as are introduced shall be delivered to an officer at Adelaide for examination, and, if thought necessary, to treatment with an insecticide to ensure freedom from living pests. No one but the Director of the Botanic Gardens is allowed to introduce plants from a phylloxera-infested country, and all such as are imported by that officer must be kept in a closed house for at least one year after their arrival.

Relation of Insects to Natural Enemies.

In an entirely normal state of nature, the relations between plant-feeding insects and their enemies remain practically the same during a series of years. These enemies are predaceous animals, such as snakes, toads and birds, and predaceous and parasitic insects. The first class, that is the predaceous animals, and a part of the second feed with little discrimination on a great variety of insects, and hence their influence on a particular species is largely in direct relation to that insect's abundance. Most of the enemies of the second class, however, confine their attention to one species or to a few closely allied species, and hence the abundance of a particular species of insect is greatly influenced by the abundance of these enemies. For a few years these enemies may keep an injurious insect in an almost complete state of subjection; but, becoming overnumerous, they perish for want of food, and the injurious insect is left to multiply in peace, which it quickly does. But its climax is soon reached, for the few enemies peculiar to the species which have survived the famine again find the land abounding in plenty, and, responding to the conditions, they in turn multiply and soon again subject the plant-feeder. Thus in a series of years, in spite of the marvellous fecundity with which Nature has provided insects, their numbers remain approximately the same. The limits in time of this "rise and fall" varies widely with respect to different insects. With some, as with many aphides, only a single season is required; with others, as with many locusts, several years are required. But always

Nature tends to preserve a balance, and under strictly natural conditions no insect long remains superabundant.

Man, however, upsets these fine adjustments of Nature. He devotes immense areas of territory to the same food-stuff; he cultivates the plants, rendering them more luxuriant, more tender and succulent. Thus he favours the plant-feeding insect. Nature had designed it to meet with privations, for less nourishing food and less bountiful provision. Under its new conditions the insect simply luxuriates. To effect its perpetuation it had been endowed with wonderful powers of multiplication, and these are now used to their fullest extent. Food is now plenty; there is room for their increase. Many birds and other small animals are not tolerated by the farmer among his crops, and thus no small degree of the check which Nature had provided to prevent an undue superabundance of the plant-feeding insect is removed. The parasitic and predaceous insect enemies remain, it is true, but these alone can wage only an unequal war, with the balance always much in favour of the plant-feeder. For these reasons the farmer must wage eternal war against plant-feeding insects.

Immense Number of Insects.

Comparatively few persons realize what an immense variety of forms is displayed in insect life. To the average Colonial farmer there are a few species of locusts, a few different kinds of caterpillars, some flies, a dozen or so "bugs," and perhaps as many beetles. Knowing so few insects, he fails to appreciate the difficulties in the study of entomology, and why, with all the entomologists, so little can often be told him regarding a particular insect.

In number of species, insects far outnumber all other classes of animal life combined. Dr. C. V. Riley, late Entomologist to the United States Department of Agriculture, published the statement in 1892 that *ten millions* would in his judgment be a moderate estimate of the number of different species of insects! The vast majority of these remain undescribed and unnamed. In the United States about twenty-five thousand species have been named and described, and of these Dr. J. A. Lintner,

the New York State Entomologist,* estimates that at least fifteen thousand are injurious, and that about half of this number, or between seven and eight thousand, may justly be regarded as pests. Of this number the same author concludes that at least one thousand are fruit insects.

The enemies of the Apple have probably been studied more than those of other fruit trees, and a recent list given by Mr. Laurence Bruner† enumerates two hundred and eighty-one species attacking this one tree, and adds that the list is still far from complete.

The number infesting some other members of the plant world is equally striking. The Oak harbours at least five hundred species according to a German authority, while over four hundred have been recorded from the same tree in the United States.

Insects are remarkable for the fecundity of each species as well as for the great number of species. If all the progeny from a single pair of almost any species of insect were allowed to survive long enough to procreate, but very few years would elapse in a land before that particular species would quite exterminate itself with all that it fed upon, so immensely superabundant would it have become.

The myriads upon myriads of locusts which overrun this country are known to all, and yet these locusts cannot be called remarkably prolific insects. The number of eggs they lay is small compared to the number laid by many other insects; at the most it is not over one hundred and fifty.

The number of individuals which might arise from one aphis during the course of a single season is almost incalculable. It amounts to billions of billions, numbers entirely beyond human comprehension. If, according to Dr. J. A. Lintner in speaking of the Hop Aphis (*Phorodon humili*), every individual should attain maturity and produce its full complement of young (which, however, can happily never occur in nature) we should have as the number in the twelfth brood alone, disregarding those of all the

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* "Some Pests of the Pomologist," 1889.

† Nebraska State Horticultural Report, 1894.

preceding broods (thirteen broods in one season have been observed) no less than 10,000,000,000,000,000,000,000 (ten sextillions) of individuals. Figures in a case like this fail to convey any adequate conception. The writer quoted, to impress the enormity of the number, makes the following computation, using space and the velocity of light, which is about eleven and one-fifth million miles per minute as his measures: "Were the brood marshalled in line with ten individuals to the linear inch touching one another, the procession would extend to the sun (a space which light traverses in eight minutes) and beyond it to the nearest fixed star (traversed by light only in six years) and still onward in space beyond the most distant star that the strongest telescope may bring to our view, to a point so inconceivably remote that light could only reach us from it in twenty-five hundred years!"

Aphides are small insects and an individual inflicts but an infinitely small drain on the sap of a plant. But when this drain is magnified a million times, the loss to the plant is sadly apparent. The number of aphides infesting a certain cherry tree, ten feet in height, was once estimated to be twelve millions, or more than seven times the total population of Cape Colony. The number which are often seen congregated on a single head of cabbage must be over one hundred thousand.

Voracity and Destructiveness of Insects.

Not alone are insects remarkable for their incalculable numbers but for their extraordinary voracity and rapid growth as well. Mr. L. Trouvelot, a French naturalist, in studying one of the silk-worms (*Telea polyphemus*, Cram.) found that the larva when full grown weighed four thousand one hundred and forty times as much as it did when hatched from the egg; and that during its growth it had consumed food to the amount of eighty-six thousand times its original weight. If man grew in a similar proportion, he would weigh twelve tons and consume two hundred and fifty tons of food. Another writer mentions a flesh-feeding larva which consumed two hundred times its weight in one day, and a certain caterpillar which increased in weight ten thousand times in thirty days.

The losses incurred through the ravages of insects are enormous. No statistics are available in this country from which to obtain accurate figures. In 1893, however, the estimated losses to grain crops caused by "locusts and other plagues" were nearly twenty per cent. of the harvest for mealies (Indian corn), about fourteen per cent. for wheat and from seven to twelve per cent. in the case of other cereals. Some of this loss was due to diseases, but probably insects were responsible for a loss of at least ten per cent. of the total harvests, and for very much more in the case of mealies. The year 1893 was characterised by an unusual abundance of locusts, but the losses during the present year (1896), although the year has scarcely begun, bid fair to be equally as great, as immense swarms of locusts (in this case *Acridium purpuriferum*, Walk.) have again appeared. The Phylloxera, too, is entailing large annual losses in the Colony, and has greatly depreciated the value of vineyards in the districts where it has made its appearance.

The annual loss through insect ravages in the United States is said to average one-tenth of the crops. Mr. B. D. Walsh, at one time State Entomologist of Illinois, thirty years ago estimated that insects annually inflicted a loss of no less than sixty million pounds sterling in the country, and subsequent writers think his estimate a moderate one. Most certainly these great losses to the agriculturist cannot be entirely checked, but to some extent they are preventable and to this extent they should be prevented.

Measures to check Loss through Insects.

For almost every insect there is a remedy. The question generally is one of applying. There is no sovereign remedy for all insects; and for some insects and important ones, too, there is no economical remedy; but there are certain general measures which if faithfully carried out will largely decrease loss from insect attack. The most important of these are clean culture and high culture.

A great many insect pests lie dormant in cultivated lands through the winter and require shelter to protect them from cold and exposure to inclemencies of the

weather and the attacks of enemies. This shelter they find in old stubble, stalks, leaves and other rubbish with which the fields are littered. From such places the insects come forth at the first approach of spring, ready to attack the new growth of plant-life as soon as it starts, just the time when the greatest damage can be inflicted with the least attack. Obviously, much benefit would here result from clean culture. The gathering of all rubbish, dead vegetable matter and other refuse from the fields, and having it burned or properly composted before winter would destroy an immense number of these injurious insects; and the ploughing in deep, or better yet the burning of old stubble would yield similarly beneficial results. Diseased branches of trees should also be removed and burned and the trunks and branches should be kept free of moss, lichens and rough bark, beneath which insects or their eggs are harboured through the winter. No weeds or foreign growth should be tolerated along fences, walls or hedges, since such places shelter insects through the winter. Clean culture is the stitch in time to save nine.

High culture is almost equally important in warding off insect attack, or rather in enabling the plant to overcome it. While the plant which is weak and sickly through lack of proper cultivation or needed fertilizing material in the soil succumbs to the attack of insects, the plant which is properly cultivated and nourished is often able to overcome the attack and mature in good condition despite the drain upon its vitality. Particularly is this true of vegetables. Take the cabbage as an example. If poorly nourished and ill-cultivated, it is almost sure to succumb to the attacks of the Cabbage Aphis and the Diamond-back Moth; but if forced into a strong and vigorous growth, the plant will head up notwithstanding large numbers of the insects.

Fruit trees kept in vigorous growth may scarcely appear to be affected by infesting scale insects, while trees poorly nourished and uncultivated die all about them when infested to a like extent. Some insects also seem to show a decided preference for plants making only a feeble growth, and many writers on entomology assert that certain insects never attack a plant unless it is in an

unhealthy condition. The second great principle in preventing insect injury is, then, keeping the crops well fed and properly cultivated.

In addition to the measures already noted, the agriculturist can make extensive use of judicious rotation of crops to repress insect ravages. This is the only practical means of combating many insects and also diseases, and is economy for other reasons as well. Many insects, being capable of subsisting only on a certain plant or class of plants, are destroyed by starvation when the soil is used for other plants. Such means, which would be a rotation of crops, would in all probability be effective against the Keever Beetle (*Heteronychus arator*, Fab.), which with closely allied species is very injurious to mealies and other graminaceous crops in the eastern sections of Cape Colony. The beetle is said never to occur in grain on ground recently broken up, even though it be within a few feet of its old field of operations. This is evidence that the insect breeds only in land planted with certain crops, and that planting the land with a crop unsuited to the tastes of the insect would prove fatal to it. As it does not become injurious at once in new ground even when this is close by the old, there is no danger that the insect will simply be driven to new fields to continue its work of devastation. It must starve in the old ground.

What crops could be substituted for mealies or the grains on the land can but be learned from experience. In the United States damage from the May Beetle (*Lachnosterna* sp.), which belongs to an allied sub-family and has many points of similarity to the Keever Beetle, is often largely prevented by rotating clover, a leguminous forage plant, with mealies and corn.

Many insects cannot be controlled by these general methods of culture and need to be dealt with by more artificial means. Much attention has been paid to such means within the last generation and several very valuable insecticides have been brought into common use. The agriculturist should be acquainted with the best of these insecticides and know for what they are applicable, for an insecticide that answers perfectly for one insect may be totally inadequate for another. In general, insecticides

may be divided into two divisions, one killing by contact and the other by internal poisoning. For the judicious use of both kinds of insecticides, it is important that the farmer recognize that insects may be divided into two classes according to their method of taking food. One class of insects, which embraces locusts, caterpillars and beetles, takes solid food by means of biting jaws; and the other class, which is made up principally of Hemiptera, the order of insects which includes bugs, scale insects, bark lice and the like, takes only liquid food, which it imbibes through a proboscis; when the insect's food is the sap of plants, this proboscis is inserted in the bark. The first class of insects as a rule can be readily disposed of by applying poisons such as arsenites to their food; while the insects of the second class are clearly beyond the reach of such poisons. Their method of taking food affixes them more or less permanently to the surface they are on, so that they are vulnerable to penetrating insecticides such as tobacco solutions and paraffine preparations, which close their breathing pores and thus suffocate them.

It is evident that the farmer cannot make use of these preventive and remedial measures to the best advantage unless he has some knowledge of the insects with which he has to deal and of their habits. Being a busy man the farmer cannot afford to devote time to the study of the complex lives of his insect foes entirely by himself; but he should sufficiently acquaint himself with entomology to be able to understand fully the reports on injurious insects which are given him by the trained entomologist. From these reports he should learn the names of his common insect foes, the characteristics of their attacks and the different stages of life through which they pass, and he should confirm as far as possible the statements of the entomologist by his own observations which is generally quite an easy matter and will aid him greatly to remember about the insects. Every insect has several stages in its life and is often much more easily destroyed in a stage that passes unrecognized by the farmer because the insect then does little or no damage, than in the stage when it is injurious. The common Blaauw Biesje (*Haltica indagacea*) is sometimes quite destructive

in gardens and orchards in its beetle stage. At this time it is difficult to combat. How many farmers know that in its larval stage this insect is a sluggish black larva feeding on common weeds, such as Tong Blaar, which grow in cultivated ground; and that by keeping these weeds suppressed they will be little troubled with the beetle? Not knowing that the larvæ feeding in the worthless weeds will in time become winged insects that attack his crops, the farmer suffers them to live, not even troubling himself to crush underfoot such that lie in his path.

To recapitulate then, every farmer should make it his business to know the insect pests of his crops and as much as possible of their habits and life-history in order that he may be able to derive the greatest possible benefit from the exercise of simple cultural measures to restrict their ravages and when necessary for him to use insecticides to use them to the greatest advantage; the four leading means to combat insects being clean culture, high culture, rotation of crops, and use of insecticides.

Necessity of Studying Insect Habits.

Every insect has a complicated life-history. In general there are four distinct stages of existence,—the egg,—the larva,—the pupa, and the imago. And these stages may differ so greatly from one another that one not acquainted with insects would never suspect their relationship. Until all the stages of an insect's life are known, it is not possible to say with absolute certainty at what period of its life the insect may be most easily destroyed. Take for an example the Calandra of the Grape (*Phlyctinus callosus*). In its mature state this insect is a beetle. Then, by such means as trapping in "pockets" of grape leaves, numbers may be captured, but meanwhile much injury has been done to the vines and young grapes. It is claimed by many vine-growers that digging the vineyard at a certain season and certain other cultural methods affect the number of the beetles, but they cannot tell how the beetles happen to be affected; and often these methods fail to be effectual. The truth probably is that there is a certain stage when the insect is very easily destroyed, that this stage is passed in the ground and is destroyed if certain

culture is given while it lasts. To tell what this stage is and how long it lasts will require long and careful study, but there is no other way of finding out.

Or again take the Codling Moth of the Apple. In the stage recognized by fruit-growers, this insect is a small caterpillar found within apples and pears. When full-grown it escapes from the fruit and hiding under loose bark or rubbish, spins a cocoon from which a moth finally emerges. The moth seeks the fruit and thereon deposits its eggs. Without a study of the life-history, no means of destroying the insects save the destruction of the infested fruit before the caterpillars make their exit would suggest itself. But a better and easier method made itself known as soon as the nature of the places which the larvæ seek when about to transform was observed. The cocoons were hunted for and destroyed or the larvæ trapped in bands of cloth or straw tied about the trees. Further observations suggested a still better remedy. The moths of the first brood were found to deposit their eggs in the calyx end of the fruit, and the young caterpillars were discovered to eat for a short time in the calyx before entering the fruit. Experiments showed that if the trees were well sprayed with an arsenite before the fruit turned down on its stem, enough of the poison would lodge in the calyx to destroy the young caterpillar. This means is far superior to the others for the worms are destroyed before they have caused any damage, and it possesses a great advantage in making each man independent of his neighbour in combating the pest. The destruction of the fruit and the trapping of the caterpillars were of little use unless everyone in the neighbourhood made use of the methods, for the moths bred in a single neglected orchard would infest the cleaned orchards all about it. Spraying is now saving upwards of seventy-five per cent. of the fruit which would otherwise be "wormy"; and is the outcome of making use of a thorough knowledge of the life-history of the insect.

Such studies as this constitute Economic Entomology which might be defined as "The study of insects injurious to the agricultural and other interests of man with a view of discovering methods for preventing or checking their ravages." As a rule these studies are laborious and

surrounded with difficulties. Many years of observation are often required to trace out the round of life of a single insect. Progress is necessarily slow, and even in those countries where most attention has been given to the subject, comparatively few insects have been thoroughly studied; while in Cape Colony almost nothing has been done in this work.

As might be expected, the United States leads in this line of research. Her immense agricultural interests have forced her to it. As elsewhere mentioned, the losses in the United States through the destructiveness of insects are greatly in excess of most other countries, owing principally to the vast areas devoted to special crops and the importation of foreign insects.

It not infrequently happens, owing largely to climatic differences, that the habits of an insect in one country differ from its habits in another country. In different climates, also, the effects of certain insecticides are dissimilar; not only to the insects they are used to destroy but to the foliage. On this account it is not always safe for Cape Colony farmers to rely upon remedies found efficient in America. American entomologists recommend the use of Paris green for the Codling moth in a proportion with water which would almost entirely destroy the foliage here. Lime-sulphur-salt mixture for the White Peach Scale proved a complete failure at Washington, D.C., while here it proved fairly successful. Therefore it is often necessary to confirm the habits of an insect when it is found in a new country before advising means for its destruction which have proved successful in other countries, and likewise to demonstrate the efficiency of the insecticide even if the habits are similar.

Some Reasons for Slow Progress of Economic Entomology in Cape Colony.

In new countries the economic entomologist labours under many disadvantages, some of which it may be well to indicate. The immensity of the number of different species of insects which are concerned in the application of economic entomology renders it perfectly impossible for

one to be acquainted with any large proportion of them at sight. Collections of preserved insects, properly arranged and named, are quite necessary to determine uncommon forms by comparison and even to distinguish between closely allied common species. In the older civilized countries entomology has been systematically studied for many generations. and collections of named insects, representative of the greater part of the insect fauna of the land, are numerous. But in new countries, where the science of entomology is still in its infancy, the collections of insects are few and far from complete. The best and almost only collections in South Africa are those of the South African Museum, at Cape Town. These are excellent collections as far as they go, and great credit is due to those who have arranged and classified them. Mr. R. Trimen, who until recently was Curator, has thoroughly worked up the Rhopolocera (butterflies) and Mr. L. Peringuey, the present Acting-Curator, is now engaged with the Coleoptera (beetles), on which he has done most praiseworthy work. The Orthoptera (locusts, etc.) have also received attention; but the vast numbers of Heterocera (moths), Hymenoptera (wasps, bees, etc.), Hemiptera (bugs, scale insects and bark lice), Diptera (flies) and other orders still remain almost wholly untouched.

This condition of affairs, though the fault of no one, makes the labours of an economic entomologist more difficult than they would be in Europe or America. For not infrequently he cannot properly determine the pest he is studying, and being thus unable to obtain its name, he cannot ascertain through records whether or not the insect is injurious in other countries and if efficient remedies have been discovered. The studying of the habits of the insect is largely comparative work. Closely allied insects generally have similar or somewhat similar habits and therefore even access to the records of the habits of the insect's near relatives is a great aid. This knowledge, to a large degree at least, is out of reach when the means to determine the insect are wanting.

Equally with a collection, an exhaustive library on his special subject is needed by an entomologist for him to work to the best advantage. Unfortunately, entomological

literature is very much scattered, and many of the most valuable works are exceedingly rare and costly, making it almost impossible for exhaustive libraries to be possessed except in the great centres of the world. The libraries in South Africa are necessarily very incomplete in entomological works, since the demand for such books is not sufficient to warrant the heavy expenditure which would be necessary to purchase even the more general works.

The variability of the climate is another detriment that the study of applied entomology meets with in South Africa. In some parts the rain falls in the winter season, in other parts it falls during the summer, and in still other parts, more or less, all the year round, while in some localities it falls very irregularly and at long intervals. The times of appearance and the habits of insects are somewhat influenced by the rains, making it unsafe to rely entirely upon studies of an insect made in one part of the Colony for application to the whole Colony. In the Eastern Province, the Peach Maggot is recorded to appear in October or even in September, while about Cape Town it does not appear until the end of the year or later.

The lack of facilities for rapid travelling has also a marked influence on the results one can accomplish in insect investigations. To travel the average one hundred miles in Cape Colony will occupy as much time as travelling fully six times that distance in America. And that country with its great wealth and population can afford an entomologist in nearly every State, and in some States several are engaged, so that with the excellent facilities for travel it is easy to have an entomologist investigating an insect in any portion of the country. Here with a scanty population we must content ourselves with a single entomologist for an extensive country.

But apart from these considerations, which are chiefly hindrances to the study of economic entomology and thereby affecting progress, our isolation from the great centres of the world and the comparatively small development of the country influence the progress of applied entomology in a much more direct manner. No apparatus for spraying is manufactured in this country, and on account of the small demand for such wares, the dealers

cannot afford to keep a varied stock on hand. In Cape Town, the dealers are very obliging and willing to import anything that there is a demand for; but until such apparatus has been seen by the farmer they are slow to demand it.

In England and America, where the population is great, it pays large companies to prepare standard insecticides ready to be diluted with water, and to sell them at moderate prices. For instance, in the Western United States it is possible to buy ready-made lime-sulphur-salt mixture and resin wash, and in some of the Eastern States, ready-made standard paraffine emulsion and tobacco decoctions. Many persons are deterred from using insecticidal washes because of the trouble involved in preparing them. Therefore such conveniences as reliable prepared washes are an encouragement to spray; and one which is quite wanting in Cape Colony. It might be well to remark, however, that the difficulty in preparing insecticidal washes at home is more often imaginary than real.

Such disadvantages as these have retarded the use of insecticides and measures to prevent or check injurious insects in Cape Colony. Their mention here is made with a double purpose:—To explain that the study of insects is slower and more arduous work here than in older countries; and to indicate that the inertness of the Colonial farmer in adopting measures to protect his crops from insect ravages is not altogether due to laziness and indifference on his part, as so many people are fond of saying, but rather to the conditions under which he labours. For example, while the American fruit-grower is confronted with advertisements of spraying pumps and insecticides everywhere he goes, and in every agricultural paper he reads, and is oftentimes harassed by agents until he gets an outfit, the fruit-grower in Cape Colony seldom sees a spraying machine mentioned except in his *Agricultural Journal*, never gets his imagination inflamed by exaggerated statements of pump agents, and far from being able to purchase spraying apparatus at his very door or having his spraying done for him, he has to send to Cape Town or other large centre for his pump, and then perhaps to wait three months or longer while his order is filled abroad. And

Paris green, the most useful insecticide, of which *twenty-four hundred tons* are said to be annually used in the United States and Canada, was unobtainable in the Colony until within a few years, and is now stocked but by few dealers. Some farmers, not knowing where they can procure it, have it compounded by their local chemist at a great expense.

Progress in use of Insecticides in Cape Colony.

Despite the obstacles and disadvantages in their way, the fruit-growers are making encouraging progress in the use of insecticides. The visits to the principal fruit-growing centres mentioned in the foregoing part of this report disclosed to me the fact that most of the leading fruit-growers realize the injury which the various insects cause in their orchards, and are adopting measures for their suppression.

Quite a number had this season for the first time made use of resin wash to destroy scale insects on citrus trees, and washes of paraffine and soap for the same purpose had been commonly used. Winter spraying with lime-sulphur-salt mixture to destroy the White Peach Scale had been used during the past winter by a few parties in Wellington and Constantia. Fumigation to destroy the Red Scale had been introduced into Wellington by Mr. P. J. Cillie, C. son, the enterprising president of the Wellington Fruit Growers' Association, and had been used in several citrus groves. And Mr. H. Meyers, the energetic horticulturist in charge of Mr. C. D. Rudd's orchards at Fernwood, Newlands, has an elaborate fumigation outfit, with which he treated the greater part of the orange and lemon trees on the estate during the past winter.

The ravages of the Pear Slug have this year been checked in a great number of orchards by the timely use of Paris green. From the Eastern Province, also, comes the tidings that insecticides are becoming more extensively used. One grower writes that he has just successfully treated a thousand orange trees with resin wash for the Red Scale. In Graaff-Reinet some spraying was done to check Codling Moth injury; but about this town there is room for an immense amount of more spraying against this

insect. Mr. Wm. Roe is here striving hard by precept and example to get his fellow-townsmen to combat this most pernicious of apple pests, but they are slow to follow his suit.

The agricultural classes of all countries are conservative and slow to take to new ideas. The isolated condition of Cape Colony has had the tendency to make farmers here even slower than the average. Therefore it cannot be expected that any large proportion of the farmers will at once do as they should in using insecticides, however much the benefit to be derived from spraying is brought to bear upon them through press notices, and the successes of their more enterprising fellow-farmers. But although progress may be slow, it will be sure, for few investments pay so well as a spray-pump judiciously used, and now that the practice of spraying has gained a foothold, the farmers will not take forever to recognise the fact.

The importers of agricultural implements in Cape Town have all expressed their willingness to stock such spraying apparatus as promises to come into demand. Already several are introducing improved styles of knapsack pumps, and sell the chief insecticides at reasonable prices.

In England and America, manufacturers have found it profitable to prepare many of the leading insecticides ready for dilution in water; and in some fruit-growing districts of America, private parties make a business of spraying orchards at moderate rates. There seems to be a chance in many sections of Cape Colony for just this sort of work; in fruit-growing sections like Wellington and Stellenbosch, an enterprising man could probably work up a really lucrative business, and need but little capital to start on.

REPORT ON INSECTS.

It is not deemed advisable to attempt a complete report upon the insects which have been studied during the period of four months covered by this report, as these studies in few cases are sufficiently complete to warrant publication. A short account of the most injurious fruit insects which have been observed will, however, be given. The report on even these is preliminary, and a more complete illustrated report on the same insects will probably be submitted later. The remedies recommended for these insects is, also, in many cases provisional, pending thorough experimentation during the coming year; but such as are given will in all likelihood be found reliable, the changes which may be hereafter made being most likely to be decrease of strength and in method of preparation.

The Peach Maggot.

(*Ceratitis citriperda*, MacL.)

The Peach Maggot needs no introduction to South African readers, since next to locusts and the Australian Bug, no other insect has gained greater infamy. A reprint of all that has been published in the *Agricu tural Journal* concerning it and which contains all the current information with regard to it in the possession of the Department of Agriculture was issued within a few months. To this I can add nothing.

The life-history of the insect as worked out by Mr. S. D. Bairstow is briefly :—That the imago or fly hibernates through the winter and coming out in the spring deposits its eggs in the fruit. These eggs hatch into maggots which burrow in the pulp of the fruit; and at maturity escape to the ground, in which they transform to puparia from which the flies soon emerge. Several generations are passed during the season, the time for one being about thirty-two days. Peaches, apricots, oranges, pears, apples, and figs are all attacked, and possibly other fruits.

In the Western Province the fly does not seem to make its appearance as early as in the Eastern. Last year late

apricots were attacked, but this year they generally escaped and few maggots have been seen prior to January 1st; while in the Eastern the fly is stated to appear as early as October.

The treatments which have been recommended for the destruction of the Peach Maggot are:—First, constant culture of the soil beneath infested trees to expose the puparia to fowls and other birds; and secondly, to gather and destroy all infested fruit as it falls.

Mr. Bairstow's account of the insect shows it to be rather inactive and slow in its movements. In these respects it resembles *Trypeta pomonella*, a related fly infesting apples in the Northern United States. The habits and spread of this latter insect has been carefully studied by Mr. F. L. Harvey, the Maine State Entomologist, and the conclusion reached that it spreads slowly from tree to tree and from orchard to orchard; and hence that "*The checking of the pest is largely an individual matter, to be worked out independently in each orchard.*" This same conclusion would seem to apply equally well to the Peach Maggot and the experiences of fruit-growers in the Western Province so far during the present season give evidence that where the fallen fruit was picked up and destroyed daily last year, little or no maggot attack has occurred.

Codling Moth.

(*Carpocapsa pomonella*, Linn.)

No other insect is such a pest to a bearing apple tree as this one. Pears, and a few other fruits are also attacked, but its injuries are practically confined to apples and pears. It originally came from Europe. How widely it is distributed in South Africa I do not yet know, but it surely occurs throughout most parts of the Eastern Province and its presence is much suspected in the Western. Mr. Wm. Roe, of Graaff-Reinet, writes me that he personally knows it to have been very destructive in Graham's Town and Albany more than ten years ago. Public attention was called to it in a long article in the *Agricultural Journal* for March 9, *1893*, when drawings of the insect in its different stages

and of infested fruit were given, and remedies advised by Mr. S. D. Bairstow.

The insect passes the winter in the larval or pupal state in a greyish-white cocoon, most often attached to the bark of the tree. From this the moth emerges about the time of the setting of the blossom; and after pairing, the female deposits her eggs on the forming fruit. Almost invariably but one egg is laid on an apple. This is placed in the calyx end which at this time is uppermost. The larva or caterpillar which hatches from the egg bores into the fruit, generally towards the core. It feeds for three weeks or more and then escapes from the fruit which often will have dropped prematurely. The larva then seeks a place of concealment and spins the cocoon within which it changes to a pupa.

In some latitudes there is but one brood a year. When this is the case, the maggot remains unchanged for some time, often until the following spring, but finally transforming to the pupa from which the moth escapes as before. In South Africa, there appears to be two broods, since from infested apples and pears sent me in late November, moths were obtained during the first week of January. This second brood in the opinion of some Graaff-Reinet fruit-growers is not nearly as destructive as the first.

The moth, with its wings outspread, measures about four-fifths of an inch. It is a pretty creature, grayish-brown in general colour, with a large roundish patch of bronze on the outer part of the fore-wings. The larva is whitish in colour until nearly full-grown, when it becomes more or less pinkish. The head is always very much darker than the body. In length, the full-grown larva measures about five-eighths of an inch.

Long experience has proved that spraying the trees soon after the blossoms set with an arsenical poison is the most efficient means of checking this pest. For spraying, Paris green is preferable. This is applied in water by means of spraying pumps through nozzles which break the liquid into a very fine mist. One pound of Paris green to 200 gallons of water is the proportion most often used. Paris green is a heavy powder which remains insoluble in the

water. When used in too strong a mixture the foliage is apt to be badly scorched, and for this reason the mixture should be kept constantly agitated while it is being used to prevent it becoming over strong at the bottom.

If freshly slaked lime, a pound for each pound of Paris green, be added to the water, all danger of burning will be removed, and a stronger mixture may be used; but the addition of lime does not obviate the necessity of constant agitation to secure an equal distribution of the poison. Arsenate of lead is an arsenical compound which is sometimes substituted for Paris green. It keeps in suspension much better, and will not injure the foliage, however strong the mixture may be. It has the disadvantage of being white, which though an advantage in showing on the foliage, renders it unsafe to leave about as it might be mistaken for a harmless powder; and further it is not manufactured as yet for sale and has to be specially prepared by a chemist, which makes it far more expensive than Paris green. Paris green is now sold at 1s. 6d. per pound in Cape Town. London purple, another arsenical compound, is used by some in place of Paris green, but as its composition is variable and as it is usually more injurious to the foliage than Paris green its use is not so commendable.

A second spraying for the Codling Moth is given about a week or ten days later to supplement the work of the first. Where the insects are very numerous a third spraying is given by some growers after the lapse of another ten days. A heavy rain following soon after spraying will necessitate repeating the work, as most of the Paris green may be washed from the trees. Some larvæ may escape poisoning but the greater part of them will be destroyed. Where the second brood is troublesome it is well worth while to keep the trunks of the trees free of loose bark and to fasten bands of straw or other material about the trunks. In this climate these had probably best be applied about the middle of November and visited once a week until the middle of January, each time being taken off and examined, and all larvæ or cocoons found under them destroyed. A little experience will show at about what date to apply the bands and when to remove them.

Collecting and destroying infested fruit is often resorted to; but with this insect there is little value in gathering such fruit, or even applying bands, unless all fruit-growers in the neighbourhood do the same.

Pear Slug.

(*Selandria cerasi*, Peck.)

This insect is reported from most of the fruit-growing sections of the Western Province, but as yet there is no record of its occurrence elsewhere in South Africa. It passes the winter in the pupa state under-ground. The saw-flies begin to appear on the wing early in October, and deposit eggs singly in incisions which they cut in the surface of the leaf. The egg hatches in about a fortnight, and the slug at once begins to feed on the surface of the leaf and the tissues beneath, but does not eat entirely through. The leaves turn dark where injured, and when much eaten fall prematurely. Pear trees suffer the most, and are often defoliated. Quince, Cherry, and Plum also suffer severely, and Apricot and Peach slightly.

The saw-fly is a shiny black insect with four transparent wings. It is small, measuring about one-fifth of an inch in length. The slug is whitish at first, but soon becomes dark from a slimy matter which it secretes. When full-grown it measures between one-half and five-eighths of an inch in length. The fore part of the body is much broader than the posterior part.

A second brood of the slugs appears later in the season, but the appearance of both broods from this season's observations is far from uniform, eggs and full-grown slugs being on the trees at the same time.

The Pear Slug is one of the easiest insects to destroy. The simplest method is by Paris green, as recommended for the Codling Moth, applied as soon as any slugs are noticed. A second application, a fortnight later, may be necessary; and watch should then be kept for the second brood after five or six weeks, and if these be numerous another spraying should be given. White hellebore, one pound to forty or fifty gallons of water, serves as well as Paris green, but is much more expensive. It must be

fresh to be fully effective. It has the advantage of being strictly harmless to the foliage, and in being non-poisonous to man.

Lime, sifted ashes, fine dirt, sand or any other finely powdered material dusted over the foliage will also prove efficacious in destroying the slugs. Such methods as these need a repetition in a few days, and are less satisfactory than spraying with Paris green or hellebore.

Apple and Quince Borer.

(*Cossus tristis*, Drury.)

Frequent complaints are made in Wellington, Paarl, Stellenbosch, and Worcester of a worm, or more properly a caterpillar, which burrows in the trunks and branches of Apple and Quince, and occasionally Pear. The mischief-maker when full-grown is a stout-bodied caterpillar about an inch and one-half in length. It is flesh-coloured, with a reddish-brown head, conspicuous black jaws, and a series of more or less distinct reddish markings down the back. The breathing holes (spiracles) along the sides show very distinctly. The caterpillar turns to a pupa within the wood; and from the pupa emerges a stout-bodied moth which measures two inches or thereabouts across the expanded wings. The body is clothed with fine grayish hairs which have a reddish cast, very noticeable on the under surface where the hair is much lighter in colour than above. The wings are also grayish, the hind ones being darkest. Each fore-wing is quite dark on the anterior part of the basal half, while the rest of the wing is marked with dashes of black. Few specimens of the moth are in my possession, and these vary considerably in the depth of colouration.

In captivity one female deposited one hundred and eighty-five eggs, mostly on the bark. These eggs were not regularly placed. They are about one-twenty-fifth of an inch in length by about two-thirds as wide, pale salmon in colour and with a finely reticulated surface.

All boring insects are difficult to destroy. When young, this one seems to frequent the wood just beneath the bark, and as its presence can be told by the excrement which is

orced out through an opening in the bark, it may then be easily dug out and destroyed. Later it bores deeper into the wood. Then it may be destroyed by means of a flexible wire forced into its burrow until it is pierced, or in some cases by injecting paraffine, carbon bisulphide or other penetrative liquid which will kill by contact. Mr. P. J. Cillie, of Wellington, states that where the young larvæ have entered, the bark of the tree is dark-coloured and moist, and states that the eggs are laid in November and December. The eggs laid in confinement were deposited late in October, but being infertile failed to hatch.

As many as nineteen larvæ, an inch in length, have been removed from one cavity in the fork of an apple tree.

The habit of this insect to infest the Quince renders the growing of this tree in hedges very objectionable where the insect occurs. The hedges in such cases become a breeding ground, from which the insects spread to surrounding apple orchards.

The American Blight
(*Schizoneura lanigera*, Hausm.)

The American Blight, otherwise known as the Woolly Aphis and by a few as the Blood Insect, is an almost universally distributed pest of the Apple. It is very injurious and is especially destructive to young trees. Both roots and branches are attacked. On the roots wart-like swellings are produced which check the supply of nourishment and induce decay. Excrescences are also caused on the parts above ground. The insect most frequently abounds about the base of the tree, about the junction of branches or suckers with the trunk and about any break in the bark. On badly infested trees the whole under surface of the branches and even the twigs may be covered. They live in masses and are conspicuous by the secretion of white threads, resembling wool in appearance which coats their bodies. When crushed they yield a blood-red stain which suggests the name "Blood Insect."

In this climate the insects appear to infest the bark throughout the year. The full-grown female is about one-

tenth of an inch in length, and wingless. From her, living young are produced. In colder latitudes, as winter approaches, egg-laying females are produced; and also, winged females which spread the infestation to other trees. This may or may not be the case here.

The pest is most frequently introduced into an orchard on young trees, and hence great care should be exercised to plant only perfectly clean stock. As a precaution, all nursery stock should be dipped in paraffine emulsion or water heated to about 150°. On the branches the lice may be destroyed by spraying or brushing the infested portions of the tree with any of the insecticides recommended for scales on citrus trees. Nothing is better than carefully made paraffine emulsion diluted with nine parts of water. Success depends almost wholly upon the thoroughness of the application of the insecticide. The insects are not difficult to kill when on the exposed parts of the tree, but if even a few out of a thousand escape the tree will soon become re-infested.

The breeding capacity of aphides is remarkable and the woolly aphis is not an exception. A single female aphis has been calculated to produce millions of progeny in her lifetime; and the number which may elaborate from a single female if all survived to reproduce during a season of three huundred days is too great to attempt to express in figures. "There would be room in the world for nothing else but aphides." This statement will emphasize the necessity of thorough treatment

To destroy the root-infesting aphides, pour scalding-hot water freely around the roots. The roots should be partially exposed, and the water near the boiling point. Resin wash, paraffine emulsion or in fact any contact insecticide may be likewise applied with success. How to prepare resin wash and paraffine emulsion is stated in the article on the Red Scale. In Australia, the American Blight was once almost a scourge. But by growing trees grafted upon varieties of Apple which are exempt from the attacks of the insect, the destruction caused by the insect has been wonderfully lessened. A list of varieties stated to be thus "Blight Proof" was published in the *Agricultural Journal* for September 19th, 1895.

Some of the apple trees now grown in the Colony are said to be blight-proof. Of these the "May Apple" has been most frequently mentioned to me. Wide-awake nurserymen in this Colony are now grafting their stock on the best of such blight-proof roots, and intending purchasers would do well to procure such trees.

Orange Aphis.

(*Siphonophora* sp.)

Probably this is the same species as is found in Australia and America (*Siphonophora citrifolii* Ash). The old aphides are shiny black, while the young ones are dull black. They cluster on the terminal growth of all citrus fruit trees and greatly retard the growth of the twigs by the extraction of the sap.

Like other aphides they multiply with wonderful rapidity, and where a single leaf is seen infested one day, a whole branch may be swarming with aphides a week later. The aphides appear very early in the spring, and a little attention when the first leaves become affected will save much attention or injury to the trees later.

The aphides are not difficult to destroy. At first the destruction of a few leaves may be all that is necessary, but later if the aphides spread and become numerous, an insecticide is desirable. Tobacco is excellent for this purpose. It should be steeped or boiled in water, and the extract thus obtained applied to the infested parts of the tree. Often the branches may be bent over and dipped into a pail of the liquid, thus making a few gallons suffice for many trees. The amount of tobacco to use depends upon its strength. One pound of Boer tobacco to one gallon of water has proved thoroughly efficacious and probably a much weaker extract would answer. Paraffine emulsion and resin wash are both very effectual. The method to prepare them is given later under scale insects. The paraffine emulsion has proved a complete remedy when diluted with fourteen parts of water to one of emulsion.

Many different species of lady-birds prey upon the Orange Aphis, but generally it is late in the season before the lady-birds become numerous enough to keep it in

check. The most common species is *Chilomenes lunata*. This is an insect measuring between one-fourth and five-sixteenths of an inch in length; it is yellow, marked with black, the black forming a network enclosing the yellow in spots. On old beetles the yellow turns to a reddish colour.

Red Scale.

(*Aspidiotus aurantii*, Mask.)*

Several different species of scale insects infest fruit trees in Cape Colony, but this one is by far the worst. It is most destructive to citrus fruit trees, but sometimes greatly injures Apple, Pear and Fig. It occurs slightly on many other trees, such as Willow, Oak, and Keurboom; and is not uncommon on some garden shrubs, particularly Roses. It is found on all parts of the tree, and is especially fond of the fruit. The scale insect itself is a minute yellow body covered above and partially beneath by a scale. The scale of the female is circular, quite flat, about one-twelfth of an inch in diameter, and distinctly reddish in colour, and with a bright nipple-like prominence in the centre. The scale of the male is somewhat smaller and more oval in outline. The young of the Red Scale are produced alive, or else the egg stage is exceedingly short. These young are lively little lice, and scatter about the tree. After awhile they attach themselves, and become coated over with a scale. The females, like those of other scale insects of this family, lose the power of motion after once becoming attached, but the males when matured are minute fly-like insects with one pair of wings.

The insect is spread from tree to tree and from place to place principally by becoming attached to moving objects such as other insects, birds, or even the clothes of people, and thus being carried; and through young stock which is infested when taken from the nursery.

The leaves of citrus trees generally turn yellow about the scales, showing well the injury that is being done. The fruit is dwarfed and much disfigured. When the scales are excessively numerous the trees become sickly, and not infrequently die to the roots. New shoots often

* Determination confirmed by Mr. L. O. Howard.

spring up only to be destroyed in a few years; and finally the whole tree may succumb. The bark of the young growth of apple and pear trees turns reddish in the vicinity of the scales.

The most successful remedy for the Red Scale is fumigation with hydrocyanic acid gas. Tents or immense sheets of air-tight cloth are placed over the trees, and the gas generated beneath by acting on potassium cyanide with sulphuric acid in water. This is the remedy most used in the great orange groves of California. It is more expensive than spraying, but it is so much more effectual that growers are willing to stand the greater cost.

Unfortunately these means cannot be generally adopted in the Colony. The initial expense of tents and apparatus places it beyond the means of most individual farmers; and the comparative small size of the orange orchards, with the uneven growth of the trees in most orchards, and the long distances betweeen farms, places the cost of fumigation beyond an economical point in most localities, even if the fruit-growers co-operated and jointly purchased an outfit. However, I believe that there are a few districts where it would well repay the orange-growers to combine to purchase an outfit, and hire a foreman with a crew of men to fumigate all their trees.

The alternative of fumigating is spraying For this there is a choice of insecticides, but resin wash is undoubtedly the best and cheapest. As yet it has not been long enough in use in Cape Colony to state definitely the strength at which it had best be used here, but a wash prepared according to the following formula has been proved effectual in a number of orchards and is the same as that used in California, making allowance for the larger gallon measure used here. It may eventually prove that a weaker wash would be equally effectual.

Resin	... ...	24 pounds,
Caustic Soda (98 per cent.)		5 pounds,
Fish-oil	... ...	3 pints (2¼ bottles),
Water	... ...	100 gallons.

To prepare the wash a kettle of a capacity at least half as great as the total number of gallons is required; that is, to make one hundred gallons of wash the kettle should

hold at least fifty gallons. A second kettle, in which to heat water, is very desirable. Place the ingredients in the cooking kettle and cover them with several inches of water, hot or cold. Bring this to a boil, stirring the mixture frequently until a solution is formed. Allow to boil briskly for from one and one-half to three hours. One and one-half hours is sufficient if the resin is not coarse and the boiling is brisk and constant, but the longer period is safer. When thoroughly cooked no free oil floats on the surface of the solution. When there is a tendency for the water to boil over while cooking, add a quantity of hot water or a very little cold. If too much cold is added, the operation of cooking is greatly retarded, so it is always better to add hot water. When cooked add hot water to half the full amount of wash, and then, after stirring thoroughly, cold water to the full amount may be added. The wash is then ready for use.

It is not necessary to use the wash on the same day that it is made, nor is it necessary to dilute it at once. It will keep indefinitely, but if the solution is concentrated it should be heated again before adding cold water.

The wash is effective on the Red Scale at all seasons of the year, but less so in winter than in summer. In California it is generally conceded that August and September are the best months in which to spray citrus fruits for this scale. These months correspond to February and March with us, and limited observations in this country by parties having used the wash seem to show that these months will prove the best here.

It has often been noticed that this wash, as well as others, is much less destructive to the scales on the fruit than to those infesting the leaves and bark. It is, therefore, when possible, desirable to do the spraying while no fruit is on the trees.

Generally, more or less of the old devitalized foliage will drop off soon after the spraying, but ordinarily this loss is not great. Hot, dry winds following the spraying may cause a much greater loss of foliage and likewise a dropping of fruit; and spraying had probably be best delayed in localities where such winds occur until the season for them is past.

Two weeks or thereabouts after spraying, the trees should be examined, and if live scales are still to be found a second spraying should be given. If the scales are dead they will easily rub off of the leaves.

Resin can be purchased in Cape Town at the rate of 12s. per hundred pounds; or if a full barrel of 240 pounds is taken, at the rate of 7s. 6d. per hundred pounds. In small quantities it sells at 3d. per pound. One brand of caustic soda comes in five pound tins, and sells at 3s. 9d. per tin. Another brand comes in three pound tins, selling at 3s. 6d. Fish-oil can be bought for about 4s. 6d. per gallon. Probably a considerable reduction would be made on large orders of both soda and fish-oil.

One hundred gallons of wash would cost for the materials about 11s 6d., estimating the resin at 3d. per pound, or about 7s., estimating the resin at 7s. 6d. per hundred pounds.

Paraffine emulsion may be used in place of resin wash, but it appears so much less effective and the cost is so much greater, paraffine costing 2s. or more a gallon, that resin wash is preferable. With the repeated use of paraffine emulsion many growers have kept their citrus trees quite free of scale.

The best formula to use in preparing paraffine emulsion is that advocated by the United States Government, making allowance for the difference between the United States gallon and our own:—

Paraffine ...	...	...	5 gallons,
Soap ...	...	...	1½ pounds,
Water ...	...	...	2½ gallons.

Whale-oil soap is preferable, but any common hard soap may be used as the paraffine is the destroying ingredient depended upon.

Cut the soap into small pieces and boil until dissolved in the water. Then while the water is still boiling, remove it from the fire and add it to the paraffine. Churn this mixture steadily with a good syringe for about five minutes, or if no syringe is at hand beat rapidly with a paddle for ten or fifteen minutes. By that time the mixture should be a stable emulsion which when allowed

to stand will not separate. For use take one part of emulsion for nine parts of water, hot water being preferable. Mix the water and emulsion thoroughly.

Many farmers have destroyed the Red Scale by using Little's Sheep Dip. Mr. J. C. Garner, the Resident Magistrate at Mount Ayliff, East Griqualand, writes that he and a number of others in his vicinity found it to answer the purpose excellently. One gallon of the dip was mixed in sixty of water, and to make sure of destroying all the scales Mr. Garner sprayed three times.

Where only a few trees are concerned, a common garden syringe will answer for applying the wash. In small groves, and even in large groves if the trees are young, knapsack pumps are excellent for the purpose; but for groves of tall trees a larger and more powerful pump, mounted on a barrel or cask, is preferable.

Three different styles of knapsack pumps are now offered by Cape Town dealers. These are the well known "Vermorel," the "Galloway," and the "Notus." Although an excellent pump for applying Bordeaux mixtures, the "Vermorel" is soon rendered useless by these washes, unless it is provided with oil-proof valves. Parties now having "Vermorel" pumps which they desire to use in applying caustic or oily washes, should obtain a set of these valves through their dealer. The cost is trifling. The "Galloway" was described in the *Journal* for October 31st. It is an admirable pump, and is unquestionably the best of the knapsack pumps. R. M. Ross & Co. and Geo. Findlay & Co. both have it, the price being about sixty shillings. The "Notus" has also been described in the *Journal* (August 22nd, 1895). This is a smaller and less powerful pump than either of the others, but is a first-rate pump for its price. Koch & Dixie sell it at forty shillings.

Any of these knapsack pumps can be adapted for use on moderately large trees by means of extra hose and a pole to elevate the nozzle, or by a metal pipe, one end of which is attached to the hose, while the nozzle is affixed at the other. This latter method I consider preferable. With the aid of such a rod, four feet in length, trees up to ten or twelve feet in height can be easily sprayed by one man. And with a rod eight feet long, two men, one

carrying the pump and the other the rod, can easily spray trees twelve to fifteen feet in height.

As suggested above, however, a barrel-mounted pump is preferable for spraying large trees. These are not stocked at present, owing to the small demand for them, but many Cape Town firms will import them to order at short notice.

Mr. Wm Roe, of Graaff-Reinet, is agent for the Nixon Climax Pump, a very good one of its class. As sold, it is mounted on a tripod, but this may be removed, and the pump placed on a barrel or tank. Provision is made for two lines of hose pipe, one of which may be directed into the liquid to keep it agitated while being used.

It is best to use a nozzle throwing a moderately coarse mist-spray. The "Vermorel" nozzle, furnished with the knapsack pump, answers very well if the cap with the largest aperture is used. The nozzles furnished with the "Nixon" are also excellent; and little improvement can be made in the "McGowen," an adjustable nozzle sold by Messrs Findlay & Co., Cape Town.

The Red Scale infests every portion of the tree, and is found on both sides of the leaves. Every scale not reached by the wash escapes destruction, and remains to start a new colony. It is scarcely probable that every scale will be destroyed by ordinary spraying, but the number of scales escaping should be reduced to the lowest possible minimum. To effect this, the tree should be thoroughly sprayed from all directions, and from within as well as from without. Spray from within first, thrusting the nozzle in among the branches, and directing it so that the back of every leaf will be hit by the spray.

Trimming out the dead branches beforehand will make the work of spraying much easier.

Brown or Soft Scale.

(*Lecanium hesperidum*, Linn.)

Next to the Red Scale this is the most common scale insect attacking citrus trees in the Colony. It also occurs to an injurious extent upon the Guava, and may be found upon a large number of other trees and shrubs. Trees

seldom die from its attacks, but their growth may be greatly retarded. The leaves and green bark are infested and rarely the fruit; young trees are often almost completely covered with the scale. Its attacks are always accompanied by a black, smut-like fungus which grows upon an exudation from the insect; and the presence of this fungus renders the insect doubly obnoxious, since the exudation from the insect, falling upon the fruit, gives sustenance to the fungus in such places, thus rendering the fruit almost unmarketable.

As indicated by its names, this scale insect is brown in colour and rather soft to the touch; oftentimes it becomes very dark. It is elongate-oval in outline, and the back is much rounded. In length the full-grown scale measures about one-seventh of an inch, and in width about one-eleventh.

The young are born alive, and like other young bark lice are very active.

The Brown Scale is disseminated by the same agencies as the Red Scale and other scales;—by infested nursery stock, and by the young being blown by the wind, or carried on the feet of birds, or attached to insects or other moving objects.

Fortunately for the welfare of the fruit-grower, this scale insect suffers much from the attacks of parasites as well as predaceous enemies. Not unfrequently, some of the scales are noticed to have become much swollen, smooth, and black, with a light-coloured border all around. These are parasitized scales; and in the back of many of these, small holes may be seen through which the parasite, a minute four-winged fly, has escaped. The common, small black lady-bird (*Exochomus auritus*), with a yellow spot on each side of its thorax, is also very useful in destroying them.

The Brown Scale yields easily to insecticides, much more easily than the Red Scale, which is protected by a firmer covering. The fumigation method or any of the washes recommended for the Red Scale may be used to destroy it, but if paraffine emulsion is used, repeated spraying will be necessary. The resin wash will also destroy the black fungus.

Peach Diaspis.

(*Diaspis lanatus*, Morg. and Ckll.) *

The Peach Diaspis, or as it is more commonly called, the White Peach Scale, is probably the most destructive scale attacking deciduous fruit trees in the Colony. It is recorded from most of the districts in the Western Province, and, with very little doubt, occurs to a slight extent in the Eastern Province near Graham's Town.

The great destructiveness of this scale insect and the difficulty experienced in destroying it has attracted attention to it in many countries. It is now known in the West Indies, Japan, Australia, Ceylon, and in a few places in the United States. I have been unable to obtain a clue to its introduction into this country, but it has undoubtedly been here a number of years. At Wellington some old fruit-growers say trees were injured by it in their boyhood, and it has been known in the Cape Peninsula for upwards of fifteen years.

The scale of the male is unlike that of the female in shape. That of the female is nearly circular, about one-twelfth of an inch in diameter, greyish-white in colour with an orange-yellow spot (the exuvia), midway between the centre of the scale and its front border. The scale of this male is about one-sixteenth of an inch in length and one-third as wide as long. The colour of the scale is much whiter than that of the female and the exuvia is situated at the anterior extremity. The male scales are often to be seen in the fluffy masses in sheltered situations on the bark.

The scale of this species of scale insect remains attached to the bark of the tree long after the death of the insect, and hence the bark often becomes very thickly coated with old scales. The young when hatched are orange-red in colour, and present such a striking contrast to the white colour of the mother insect that they are very conspicuous on the bark. Soon they become coated with a mass of curly, waxen threads and later the scales form over them.

The trunk and branches of the tree generally become the most infested, but the insect spreads to the twigs and slightly

* Determination confirmed by Mr. L. O. Howard.

onto the foliage. As the fruit approaches maturity, it, too, becomes infested, even becoming deformed in severe cases. On the fruit the presence of the insect causes small, round, reddish discolourations, often much marring its appearance. Infested trees become much weakened, and not uncommonly are killed. Several broods of the insect must occur during a season. Thus far this year at Mowbray one was observed to hatch in early September and a second appeared shortly after the middle of December.

Besides the Peach many other trees are attacked. The Mulberry suffers as severely as the Peach. Apricots have been seen badly infested and Plums do not escape. A few slightly infested Pears have been observed, and many garden shrubs and flowers are much injured.

In several places, but most notably at Wellington, this insect is parasitized by a minute chalcid fly of the genus *Aspidiotophagus**. At least five species of lady-birds prey upon it, and also a species of Aphis-lion. Unfortunately, none of the lady-birds can at present be determined. All but one are small. The exception is a species of *Exochomus*. It is about one-fifth of an inch in length, of a black colour and and ornamented by a large reddish spot in the middle of each wing-cover.

As has been intimated, the White Peach Scale is not an easy insect to combat. Like all other scale insects, its most vulnerable period is just after the eggs have hatched. At this stage it is reddish in colour and is active on the bark. It then readily succumbs to treatment with paraffine emulsion made as recommended in the article on the Red Scale, or to resin wash. Unfortunately the date of the hatching of the eggs appears to vary with the locality and situation of the trees, so that no exact date can be given for this spraying. The proper time could best be told by keeping watch on the insect during the early spring; in most places it will probably be during the last week of September. A second spraying a week or so after the first should be given to destroy those that hatch after the first spraying.

Spraying to destroy the adult insects after the foliage has started into growth is useless. Any known wash that

* Possibly *Aspidiotophagus citrinus* (Mr. L. O. Howard).

would kill the insects would kill the foliage also. Winter spraying with strong washes has a better effect. A variety of washes may be used. Experience has yet to prove which is the best. At Wellington and Constantia, last season, lime-sulphur-salt mixture was used with much—though far from complete—success. In the Eastern United States this mixture proved almost worthless, a difference probably due to climate. Here, air-slaked lime was used in preparing the wash in place of quick-lime. It is possible that better results would have followed if the latter form of lime had been employed.

The formula to use in making the lime-sulphur-salt wash as published by the Los Angeles Horticultural Commission, which is essentially the same as that used in Wellington, is as follows :—

Unslaked lime	40 pounds,
Sulphur	20 pounds,
Stock salt	15 pounds,

Water to make 60 gallons.

"Place ten pounds of lime and twenty pounds of sulphur in a boiler with twenty gallons of water, and boil over a brisk fire for not less than one hour and a half, or until the sulphur is thoroughly dissolved. When this takes place the mixture will be of an amber colour. Next place in a cask thirty pounds of unslaked lime, pouring over it enough hot water to thoroughly slake it; and while it is boiling add the fifteen pounds of salt. When this is dissolved, add to the lime and sulphur in the boiler and cook for half an hour longer, when the necessary amount of water to make the sixty gallons should be added." Strain and use while warm, keeping the mixture well stirred.

This wash is said to possess some fungicidal properties, destroying all growth of moss and lichens on the trees and killing the spores of Shot-Hole Fungus and Peach Leaf Curl, when used as the buds begin to swell. Mr. P. J. Cillie, C. son, of Wellington, in his pamphlet, "Selected List of Fruit Trees," states that spraying in July was very successful in preventing the Leaf Curl in his peach orchard.

Resin wash, made one-half stronger than recorded for the destruction of the Red Scale, is a favourite winter wash for deciduous trees in California. In the experi-

ments carried on at Washington, D.C., for the destruction of the White Peach Scale, it proved more successful than the lime-sulphur-salt mixture, and it has the advantage of being less difficult to prepare and apply.

The formula to use is:

Resin	36 pounds,
Caustic soda (98 per cent.)	$7\frac{1}{2}$ pounds,
Fish-oil	$4\frac{1}{2}$ pints ($3\frac{1}{2}$ bottles),
Water	100 gallons.

The directions for making are the same as for the weaker preparation.

Resin wash also has some slight fungicidal properties and can be used in connection with Bordeaux mixture. Mr. B. T. Galloway, the chief of the Department of Vegetable Pathology of the United States Department of Agriculture, suggests that the combination of the two will prove to be effectual both as an insecticide and fungicide. The idea is quite new, however, and I know of no experiment to prove the double value of the preparation.

Winter washes of paraffine and soap for the destruction of the White Peach Scale have been used in many Colonial orchards. That most successful was equivalent to standard paraffine emulsion diluted with four or five parts of water.

One grower reports having used one-third of a tumbler of Little's sheep dip dissolved in five gallons of water added to five gallons of boiling water in which a bar of ordinary blue mottle soap had been dissolved. This was used when the trees were in foliage and is said to have been very effectual in destroying the scales. The foliage was not injured.

Starch paste, and also a mixture of cow dung and clay are used by some farmers, but these remedies, especially the latter, are not applicable for treating the whole tree from the collar to the ends of the twigs as is necessary to get satisfactory results.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

For the Year 1896.

CAPE OF GOOD HOPE.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1897.

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Cape Town, March 10, 1897.

The Honourable the Secretary for Agriculture.

SIR,—I have the honour to present herewith my report for the year 1896. Part I. deals with general work of the year, and Part II. is a paper entitled "Some Orchard Pests," which is designed to furnish timely information on certain groups of insect pests of considerable importance to fruit culturists.

CHAS. P. LOUNSBURY, B.Sc.,

Government Entomologist.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1896.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1897.

REPORT OF ENTOMOLOGIST.

Assistance.

The entire work of the office has been personally performed. An application for an assistant was made early in the year, as a great deal of time was spent on work which though necessary could be equally well done by a subordinate. The Department approved of the request, but no funds were then available for the purpose, and so no steps toward securing anyone could be taken other than placing the requisite amount on the Estimates for the coming year. The appropriation was duly made. Up to the time of writing, the post has not been filled owing to difficulty in finding a suitable person; but there are several applications on file, and, probably, the appointment will soon be made.

Correspondence and Publications.

Enquiries concerning insects addressed to the Editor of the *Agricultural Journal* have generally been referred to me, and have usually been replied to through the medium of that paper, while all enquiries which have come addressed to me have been answered by private letter. The latter have been very numerous and have required a large amount of time; they have come from all parts of the colony, and a few from the Orange Free State, the South African Re-

public, and Natal. All have been answered at length and in as cordial a manner as possible, to encourage further correspondence.

The publications which have appeared over my name in the *Agricultural Journal* during the year are cited below by their headings. They have consisted of letters written in reply to enquiries, and of articles on entomological subjects which at the time of writing had some special application. The title is given first, followed by a word to indicate whether the publication was in the form of a note, answer to a letter, or contributed article. The half-dozen figures used to illustrate the articles were from engravings made from my own drawings.

Heading.	Form.	Issue.	Page.
Thorn Tree Scale ..	Letter	Jan. 23	43
Calandra ..	Article	Feb. 6	63
Moths and Weevils ..	Letter	,, 6	64
Beetle Plague in Albany ..	,,	,, 20	98
Borer in Vine Sticks ..	,,	,, 20	98
Prevention of Peach Maggot ..	Note	March 5	110
Spray for Red Scale ..	,,	,, 5	110
Spray Pumps ..	Article	,, 19	135
Lucerne Caterpillar ..	Letter	,, 19	145
Common Swallow-tail or Orange Butterfly ..	Note	April 16	193
Destruction of Locusts ..	Letter	,, 16	200
Giant Locusts ..	,,	,, 30	228
Paraffine Emulsion for Woolly Aphis ..	Letter	May 14	258
Scale on Pride of India ..	,,	,, 14	259
Locust Fungus Disease ..	Article (illustrated)	June 25	330
Winter Wash for Fruit Trees ..	Article	July 9	347
Thorn Tree Scale ..	Article (illustrated)	,, 9	361
Fig Beetle ..	Letter	,, 9	362
Locust Fungus Disease ..	Article	,, 23	391
Weevils in Corn ..	Letter	Aug. 6	419
Alleged Remedy for Phylloxera	Article	,, 20	430
Keever Beetle ..	Note	,, 20	446
Ants ..	Letter	Oct. 1	520
Pear Tree Slug ..	Article (illustrated)	,, 1	520
Codlin Moth ..	,, ,,	,, 15	534
Australian Bug-destroying Lady-bird	Note	,, 15	545
Borer in Vine Sticks ..	Letter	Nov. 26	629
Bryobia Mite on Pear Trees ..	,,	Dec. 10	651
Tree Froghopper ..	Letter (illustrated)	,, 10	652
Locust Mite ..	Letter	,, 24	672

Early in the year, a report of 23 pages, entitled "Fruit Pests and Legislation Concerning Them", was submitted and published. It was addressed to the Board of Horticulture, and treated of a few important orchard pests, but was more especially designed to draw attention to the danger of introducing injurious insects from abroad and of spreading such as are already in the colony.

A "Spray Calendar" was compiled and published in March. This recommended remedial measures for the more important insects and plant diseases which affect orchard trees. It was arranged in tabular form and gave instructions for preparing the insecticides and fungicides which were recommended, and also told the approximate costs of the materials needed and where they could be procured. A translation in Dutch was printed on the reverse of the sheet. One thousand copies on very heavy paper were distributed among the various fruit growers' associations, and a copy on lighter paper was sent with each *Agricultural Journal*.

Field Investigations.

Out-of-door studies on a number of insects have been carried on during the year, and some of the results of these studies have been incorporated in the appended report on orchard pests.

Calandra.—The so-called Calandra (*Phlyctinus callosus* Bohem.) has received considerable attention. This beetle is the most injurious insect enemy of the vine in the grape-growing district of Constantia, and has attracted attention as a pest of importance in vineyards in most parts of the Western Province. No previous studies have been made on its life-history. Large numbers of the insects were kept in cages, and observations were made at intervals of a week or a fortnight in the vineyards for several months. In this way the different stages of egg, larva, pupa, and mature insect have been found; the early stages are passed on the roots of the vines, and thus the vines are injured in a way not suspected by the farmers. The studies will be published at some future time.

It was hoped that vine growers would assist in investigating this insect, particularly by recounting their experiences with preventive and remedial measures, and with this idea I drew up a circular inquiry and had several hundred copies distributed among the members of the fruit growers' associations in the districts where the insect was known to occur. The inquiry was also published in the *Agricultural Journal.* Most of the questions were worded so that a single word would suffice for an answer. The utter futility of thus seeking to gather information from our farmers became, however, painfully evident from the fewness of the replies which were received. In all, these numbered five, and four of these were from parties whom I had addressed personally or else spoken to on the subject.

Quite a number of vineyardists about Constantia have met with considerable success in the use of lime applied liberally to the soil about the vines as a remedy for this pest; but while effective on some occasions, it has proved a complete failure on others. Thinking that the difference in action might be due to difference in time of application, I suggested to Mr. A. Albrecht and to Mr. J. P. de Waal, respectively the president and the secretary of the Constantia Fruit Growers' Association, that they make applications of lime to different badly infested portions of their vineyards, at intervals of a month through the winter season. These proposed experiments were carried out, but the results have been disappointing, the lime apparently having little if any effect on any of the plots. Neither grower, however, is discouraged, and both will renew their experiments during the coming season. They are now inclined to believe that the action of the lime depends more upon its caustic properties than it does upon the time and manner of its application. The lime that was used this year seems to have been very poor in quality.

It should be explained that it is customary to slake the lime sold in the colony, or at least in this part of it, by throwing water upon it before it is removed from the kilns; also, that the commercial substance varies greatly as regards purity. During June, I obtained from one of the principal Cape Town firms dealing in lime samples of what was sold

as first-class limes; one sample was of lime burned from shells, and the other of lime burned from limestone. These were analyzed for me by the senior analyst of this department. In the shell-lime, there was a total of 57 per cent. of lime, one-fourth of which was in the form of carbonate; and in the stone-lime there was a total of 31 per cent., about one-third of which was in the form of the carbonate. These analyses serve to show how impure much of the lime sold must be.

Karroo Caterpillars.—Early in April, complaints were received from the Zwart Ruggens Farmers' Association concerning caterpillars which swarm in countless myriads on the veld over large sections of the Midland districts at certain seasons of the year, and cause great damage to the pasturage. Correspondence on the subject followed, and the Association was finally promised that the entomologist would visit the territory infested by the insects, and after investigating the matter, would report and discuss preventives and remedies.

The caterpillars, it is said, appear soon after rains during the summer, and their coming is preceded by immense swarms of moths. The appearance of moths at Klipplaat was reported to me early in October, and I immediately proceeded to the region. From two to three weeks were spent among the farmers, but the threatened invasion failed to occur, perhaps owing to the earliness of the season. Information on the subject, however, was collected, and specimens of the moths secured; and I had the pleasure of meeting and addressing the members of the Zwart Ruggens Farmers' Association at Aberdeen on the occasion of their quarterly meeting.

The damage is not all caused by a single species of insect, but in most localities the chief pest is *Loxostege frustalis.** I hope to continue the investigations during the coming months, and to be able to make a satisfactory report on the subject. A short paper, embodying what has already been learned, has been submitted for reading at the annual meeting of the Association in January.

* Determination by Lord Walsingham.

Peach Fly.—This insect (*Ceratitis capitata*) is a great drawback to fruit-growing in many sections of the colony, and if reports are true, is alike injurious in the other South African states. During the past year I have personally reared it from peaches, nectarines, apricots, pears, guavas, apples, quinces, loquats, and oranges; also from the fruit of the Kafir Plum (*Harpephyllum caffrum*). The insect which infests blackberries in the Western Province, and which is thought by the fruit-growers to be identical to the Peach Fly, has been reared and found to be an entirely distinct insect belonging to the allied genus *Trypeta*. The maggot found in melons, cucumbers, and other allied fruits in some sections of the country also proves to be distinct from the one in peaches; it has been identified as *Dacus ferrugineus* Fab.*

The loquats from which the Peach Fly was reared were gathered in Graham's Town. A large percentage of the fruit on the trees was infested. As far as I can learn the loquat is not often attacked in this colony, and I have not heard of its ever being attacked in the Western Province. Oranges are attacked in both eastern and western parts of the colony.

Codlin Moth.—This fruit-infesting insect was found in several orchards in the Stellenbosch District, and it appears to have become well established there. Not unlikely it will become a serious pest in the many pear orchards planted out in this district, and in time will spread to other fruit-growing sections of the Western Province. The owners of some of the affected orchards are doing their utmost to check the pest. Several orchards of old trees have been cut down, and the infested fruit on the young trees has been picked off and destroyed. It is reported that apricots have been slightly infested this season.

To bring this pest to the notice of the fruit growers, I attended the September meeting of the Stellenbosch Fruit Growers' Association. Specimens of the insect in its different life stages, and a diagram were used to illustrate a talk then given.

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* Determination by Coquillett, U.S. Dept. Agr.

Similar talks were given at several meetings held in the Graaff-Reinet District during October. In this district the Codlin Moth is very destructive. The insects were ovipositing at the time of my visit, and the opportunity was taken of searching for eggs. Not many were found, but curiously enough, few of these were at the blossom end of the fruit, where they are said to be usually placed. However, the larvæ, which had hatched, all appeared to have entered the fruit at this place. At this time (October 20th) some fruit was fully an inch in diameter and already contained the caterpillar, while unopened fruit buds were yet common on the trees, and many of the insects had not yet emerged from their cocoons. Such irregularity in the appearance of the moths and in the setting of the blossoms make repeated applications of insecticides necessary. An illustrated article on the Codlin Moth, describing the various stages and recommending remedies and preventives, was published in the *Agricultural Journal* for October 15th.

Experiments with Insecticides.

Some attention has been given to experimenting with various substances as insecticides, but the lack of the necessary time has prevented me from making elaborate series of tests.

Resin Wash.—Resin wash prepared with varying proportions of the ingredients has been tested without being able to improve on the formula recommended for use in my last report. The proportion of soda in this formula appears to be just sufficient to saponify the resin. It was found that the prolonged cooking was unnecessary when this formula was used and a sufficient quantity of water used in the preparation. The quantity of water needs to be little more than 20 per cent. of the total to which the wash is generally diluted. The formula and the revised directions for preparing the wash are given in another part of this report. By carefully following the directions, the wash may be prepared in a much shorter period of time than has heretofore been considered necessary and in a more concentrated condition.

The first published directions for preparing resin wash without prolonged cooking that I have seen are given by B. T. Galloway, Chief of the Division of Vegetable Pathology, United States Department of Agriculture. (Insect Life, Vol. VII, p. 129.) The formula given is different from the one generally used. I experimented with washes made according to these directions but failed to produce a concentrated and permanent solution. Another formula and directions are given by assistants of Mr. Galloway, in the bulletin entitled "The Principal Diseases of Citrous Fruits in Florida." On comparing the formula with the one adopted here, it appears that the two are practically identical when proper allowance is made for the difference between the American and the Imperial gallon measures. Mr. Wm. Roe, of Graaff-Reinet, published directions for preparing a resin wash without long cooking in the *Agricultural Journal* for June 13th, 1895. Mr. Roe placed the resin in a cullender and suspended this in the boiling solution of soda.

Hot resin washes were found to give much better results than cold ones, the difference in effect being very noticeable when the applications were against the Red Scale. In one case, two badly infested trees of about the same height and standing side by side were treated with the same strength of wash and within a few minutes of each other; the wash applied to one was at a temperature of 125 degrees, and that applied to the other, at 80 degrees. After a few months, the tree treated with the hot wash was almost free of scale, while the other, though in a much improved condition, was still much infested. The Brown Scale was found to succumb to a cold wash that had little effect on the Red Scale.

Single sprayings against the White Peach-Scale were made with hot and cold washes containing resin in the proportion of 24 to 55 pounds of resin to 100 gallons of water; but while all of the washes destroyed the young scale insects, the adult females proved proof against even the strongest. Rain followed 36 hours after the stronger washes had been applied and may have affected the results; but the applications of the strengths containing 36 pounds and less of resin to 100 gallons of water were on the trees

for three full days of cloudless weather before the rain fell.

Resin and Soda Washes.—Parallel tests of resin washes lacking fish-oil were made. Such washes proved less effectual, pound for pound of resin contained, than the ordinary resin wash; but when the washes were used hot and at the normal strength (24 pounds of resin to 100 gallons of water), a large percentage of the Red Scale on the trees were destroyed by one application.

Sheep Dips.—Carbolic sheep dips are now and then reported by farmers as efficacious in destroying scale insects, and to test their value in comparison with resin wash several trees were sprayed with them. Little's (liquid) dip was used in the proportions of 1 gallon of dip to 25, 40, and 60 gallons of cold water on three peach trees which were much infested by the White Peach-Scale. In no case were any of the adult insects destroyed. The proportion of 1 gallon of dip to 40 of water was then used against the Red Scale on orange trees, but with no better success. McDougal's dip (soft soap consistency) in the proportions of 1 pound of dip to 2 and 4 gallons of water also failed to destroy the adult females of the White Peach-Scale; the more concentrated of the two solutions was at a temperature of 150 degrees in the spray tank. The weaker wash was also applied against Red Scale, and without success.

The applications of the sheep dips and of most of the resin washes were made between the 17th and the 23rd of May. The temperature of the atmosphere varied from 55 to 70 degrees. In all cases the applications were made during sunshine.

It should not be inferred that the sheep dips are valueless against scale insects. They will suffice for the destruction of the young insects, and hence several applications at intervals of a few weeks will gradually destroy most of the infesting insects.

Paraffine Emulsion.—Paraffine emulsion was used experimentally against the Pear Leaf Blister Mite. It

was prepared according to the Riley-Hubbard formula and diluted respectively with 9, 7, 5, and 3 parts of water to each one of the stock emulsion in the series of experiments, and applied during fine weather in the middle of August.

The characteristic blisters caused by the mites subsequently appeared as numerous as on unsprayed trees on those treated with the 1 to 9 emulsion, about one-third as numerous on those sprayed with the 1 to 7, while none appeared on those sprayed with 1 to 5 and 1 to 3. The numbers of the blisters which appeared on the unsprayed trees, however, varied so much that it could not be inferred with perfect assurance that the stronger mixtures were an unqualified success. It is intended to duplicate the experiments during the coming winter.

Starch.—Starch paste has frequently been mentioned to me as efficient against scale insects. As it is a substance which is generally in the house, and therefore one which might often be used in town and suburban gardens providing it was proved a success for the purpose named, a number of citrus trees were sprayed with it to ascertain its value against the Red Scale. It was prepared as it is ordinarily prepared for the laundry and applied very hot by means of a spray pump. Different dilutions were tested, but none removed over one-half of the scales. It is not, then, a substance which it will pay to use. One pound of starch to two gallons of water was used in the application which removed the largest proportion of the scales. (See page 57.)

Horticultural Board Work.

The chief work performed by the entomologist for the Board of Horticulture during the year has been in connection with a demonstration on a large scale of the efficacy of hydrocyanic acid gas in destroying the Red Scale of citrus trees.

This Red Scale has been a great drawback to the raising of citrus fruits in the colony for many years. In the districts represented by the members of the Board of Horti-

culture, the ravages of this insect have been especially severe. The pest was present in almost every orchard and on almost every tree. The majority of the trees were in poor condition because of it, and much of the fruit sent to the market was badly infested. Most of the farmers did nothing at all to check the insects, and the few that did were discouraged by want of success.

There was some agitation on foot for an Act of Parliament to make compulsory the cleansing of all orchards in districts where a certain proportion of the fruit growers were in favour of the enforcement of such an Act. But, clearly, it was unreasonable to expect the fruit growers to adopt a measure like this when it seemed impossible to them to successfully and economically combat this Red Scale, one of the most common and widely-distributed of the orchard pests. The Board was of this opinion, and deemed that it was highly desirable to give the fruit growers convincing proof that this pest could be kept under.

Through the entomologist, the Board had, during the closing months of 1895, done something towards drawing attention to remedies for the pest. The entomologist had visited Wellington, Paarl, Stellenbosch, Constantia, and Worcester, and had discussed the matter at fruit growers' meetings; and further, had held many out-of-door meetings, and showed those in attendance how to prepare and apply resin wash, which is the best wash to destroy the insect; and, also, had shown how trees were fumigated with hydrocyanic acid gas. By this means a few farmers had been encouraged to spray their trees, and thus, some little good was done; but the indications were that progress would be slow and unsatisfactory. Something on a larger scale seemed needed to appeal to the majority, and this the Board resolved to give.

The matter was discussed at length at a meeting of the Board on the 31st of March, and the following resolution was adopted:—"It was resolved that the entomologist be authorized to procure a spraying outfit, and to engage a competent operator for the purpose of dealing with Red Scale on orange trees, and that some district be selected in which to commence operations." The idea was to choose some district and to spray the citrus orchards therein situated at

so slight an expense to owners of the trees that all or nearly all of the trees would be offered for the treatment. It was hoped to so greatly improve the condition of the trees, that the owners would realize the importance of keeping the insect in subjection, and be induced to do their best to keep the trees clean in the future; and, moreover, that the people in the neighbouring towns would be impressed by the marked improvement in the trees and fruit and thus be led to clean their orchards.

The Department of Agriculture approved of my carrying out the wishes of the Board, and I visited the chosen district, which was part of Wellington. A brief inspection sufficed to show that here was a rare chance to demonstrate the value of fumigation with hydrocyanic acid gas. To spray the trees would take more time for two or more visits to each farm would be necessary. Moreover, the fumigation process had been proved in California to be by far the more efficacious of the two methods. Therefore, action was postponed for the present, as the resolution referred to spraying; and a paper was submitted to the Board at its next meeting setting forth the relative merits of spraying and fumigating, and recommending that the latter method be adopted in the projected work. The recommendations were accepted, and I was empowered to procure a fumigation outfit and to proceed with the work, aided by the two members of the Board resident in Wellington. Accordingly, the necessary chemicals were at once ordered, and an outfit of tents and sheets for covering the trees prepared.

The outfit is modelled after that of the Los Angeles County Horticultural Commission, as described in the *Rural Californian*, for June, 1895. Additional information was received from Mr. John Scott, the Horticultural Commissioner of the same county. Most of the cyanide used has been imported direct from Germany. The actual work of fumigation was commenced in early September, and has continued through the remaining months of the year. The tents in use are twenty-two in number, and range in size from six to sixteen feet in height; the sheets are six in number, and range from thirty-three to forty-eight feet across. The tents are used to cover small trees, and the sheets for those above twelve feet.

A full description of the outfit will be given in a report which will soon be submitted to the Board of Horticulture, and, hence, is not necessary here. Information as to the cost of the equipment and of the necessary chemicals will also be given. Three months were spent in Wellington, and then the outfit was taken to Groot Drakenstein, and from there to Banghoek, in the Stellenbosch District, where it was at work at the close of the year. The direct charge of the work was entrusted to Mr. P. J. Pentz, of Wellington, to whom credit is due for his successful management and for the success of the work. Mr. Pentz has acted under my instructions, and I have visited the work on the average of once a fortnight.

The public have been informed from time to time of the progress of the work through the newspapers, and on several occasions have been specially invited to visit orchards being treated to become acquainted with the operation.

While the fumigation process was used to clean most of the trees, some attention was paid to spraying with resin wash to demonstrate that it, too, was effective against the insect.

I believe that the Board has succeeded in accomplishing the end it had in view, that is, in proving to the fruit growers that the scale can be successfully combated. And despite of the adverse conditions of small and scattered orchards of all heights of trees, I am now firmly of opinion that under a proper system of co-operation or of skilful private management, the fumigation process may be undertaken at figures which would represent only a small fraction of the benefit derived in, at least, the Divisions of Wellington, Paarl, and Stellenbosch.

Australian Lady-Birds.

An attempted introduction of several species of Australian lady-birds was mentioned at some length in my last annual report. Although subsequent sendings of the insects from Australia had been promised by the Department of Mines and Agriculture of New South Wales, none were received,

probably owing to the changes in the departmental staff arising from the death of Mr. Oliff, the entomologist.

Orcus australasiæ.—Of the three species of lady-birds received fifteen months ago only one, *Orcus australasiæ*, has been seen during the past year; but fortunately this one now appears to be permanently established in its new home. For many months there were no signs of it in the orchard where many had been set at liberty, but a few could always be found in the glass-house where the greater number had been placed. It was supposed that all of those out of doors must have perished, and arrangements were made to fumigate the trees with hydrocyanic acid gas. But while awaiting the arrival of the outfit, which, because of a long delay in procuring cyanide had been temporarily stored, beetles and larvæ were found in small numbers, not only on the tree on which the original stock had been placed, but on trees in other parts of the orchard. While not numerous on any one tree, enough of the insects were found to indicate that they were there to stay.

The orchard is at Fernwood, Mr. C. D. Rudd's estate, Newlands, and is worked by Mr. Henry Meyers. The trees have almost ceased to bear owing to the scale insects, and Mr. Meyers would much like to have them fumigated, as he has long since ceased to hope that the lady-birds will ever be capable of reducing the scales to uninjurious numbers; but realizing that the fumigation of the trees would mean the destruction of the lady-birds, he has very kindly agreed to allow the trees to remain in their present condition.

It is unlikely that this or any other lady-bird will make the use of insecticides against the Red Scale needless. They may, however, materially decrease its destructiveness. The go-ahead fruit grower who sprays his scale-infested trees will not derive much benefit from their presence, but they will be a great boon to the owners of small fruit and flower gardens who, for one reason or another, do not employ insecticides.

Vedalia cardinalis.—The distribution of this Australian Bug-devouring lady-bird is still continued by the Depart-

ment, but now a charge of 10s. is made for each colony (see page 98).

During the year a large colony was sent to St. Helena, by request of the Acting Governor. The lady-birds arrived at their destination in good condition. Previous colonies sent to the island had died out, and the Australian Bug again threatened to become destructive. On two occasions large numbers of the lady-birds were caged and sent to Mauritius, but in neither case did more than a few survive the long voyage, which in both cases was protracted; and what did survive died soon after their arrival without breeding. Another colony will be forwarded when the opportunity offers. The difficulty is in securing the insects and sufficient food at a time when a vessel is about to sail for the island.

Migratory Locusts.

While I have little to do with the locust question that confronts the colony, I would hardly be justified in omitting all mention of the destructive species which ravaged a large portion of the country during the past year.

The species in question has received many popular names, among which are Red-Winged Locust, Egyptian Locust, Coast Locust and Kalihari Locust. The scientific name is *Acridium purpuriferum*, Walker. This determination is from specimens in the South African Museum, which in turn were determined by comparison with the type specimen preserved in the British Museum; the type was collected in South Africa. This species is thought by some to be identical with the migratory locust (*Acridium peregrinum*) which occurs in northern parts of Africa and which from time to time becomes troublesome in Algeria. But a comparison of specimens of the two species at once shows marked differences.

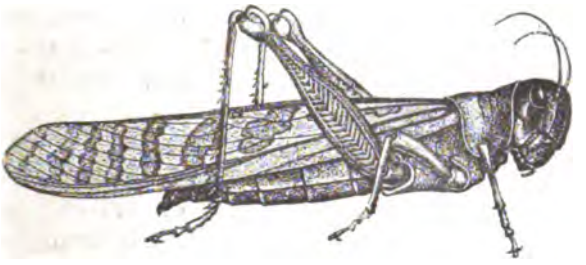
The Red-Winged Locust is illustrated on the accompanying plate. The drawings from which the engravings were made were drawn from life by Mr. Arthur Rich under my direction, and are very exact in detail. The figures are natural size.

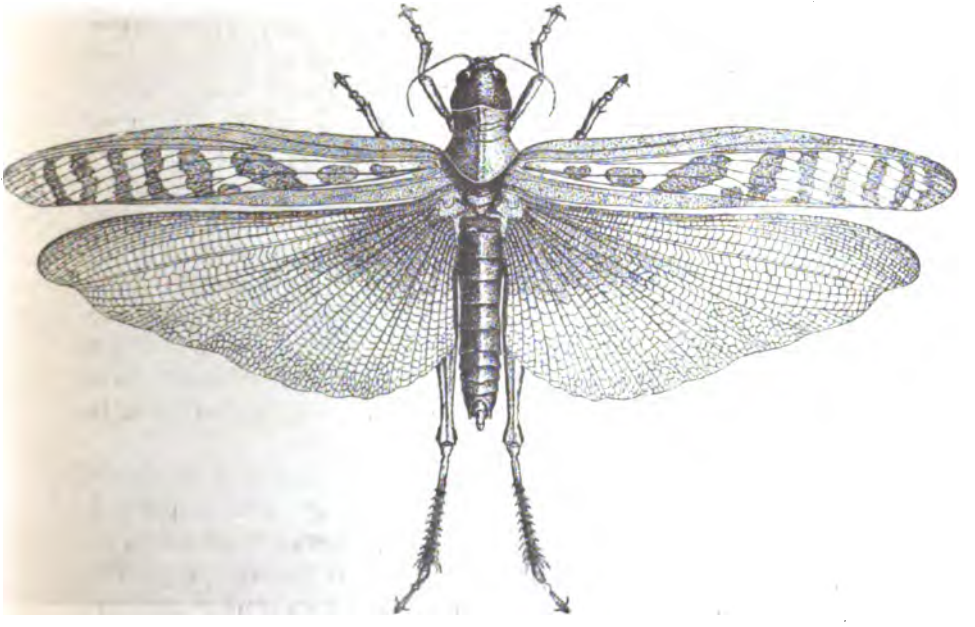
The markings on the fore-wings vary slightly in shape on different individuals and are not always exactly similar on the two wings of the same insect; but from the examination of a large number of specimens from different sections of the Colony, it is seen that this variation is seldom much and never sufficient to cause confusion with *Acridium peregrinum.*

There appears to be considerable variation in the colour of the mature insects dependent upon age. The specimens represented in the illustrations were received during February, at which time the swarms were ovipositing. These possessed no distinct thoracic markings, but the bases of the hind wings were reddish as represented by the shading in the figure. The eggs laid by the locusts in February hatched in a few weeks in those districts blessed with rain and by the latter part of July, winged individuals of this second generation appeared. Through the kindness of Mr. W. C. Palgrave, the Civil Commissioner of George, specimens of these newly fledged insects were received. They were brighter and, altogether, somewhat darker than the specimens before received. Both body and appendages were tinged with red, but there was no trace of colour on the hind wings. The most striking difference was a broad band of white which extended from the top of the head across the thorax and more than half the length of the folded wings. As the season advanced, other specimens were received in which the white marking was less apparent or entirely obliterated, the reddish tinge of the body and of the appendages more conspicuous, and the hind wings lightly tinged with red. Later still, other specimens were received in which the red of the body and appendages had almost disappeared, and the general colour faded to a dingy yellow, the same as in specimens received ten months before.

The destruction caused by the invasion of this species of locust was very great, but as the damage was largely to grazing lands and to crops already suffering from drought, it is impossible to tell to what extent of damage they were responsible. Probably none of the large swarms originated in the colony, although scattered small swarms had been present along the coast east of East London since the latter

PLATE I.





Red-Winged Locust, *Acridium purpuriferum*, Walker.

part of 1893. The presence of large swarms was reported in the border districts of the north and east in early December. The swarms from the east moved steadily along the coast while those from the direction of Kalihari moved south-east, all of the swarms thus converging on the coast lands. The infestation then gradually spread along the southern coast, covering a strip of territory about 50 miles in width as far west as Swellendam. The swarms dwindled in size as they spread westward and almost disappeared by the end of February. No swarms were reported from west of Swellendam but scattered individuals reached Robertson and Worcester. In all, the swarms passed over about two-thirds of the colony.

Immense numbers of young locusts appeared in the districts along the south coast soon after the old locusts had disappeared, and for a short time, it seemed as if the devastation was to be immediately continued. But this section of the country has the advantage of winter rains. The moisture, evidently, was needed to cause the hatching of the eggs, but the continued moist weather proved very unfavourable for the development of the young insects, and soon they were reported to be dying in myriads. Specimens of the insects forwarded for examination showed that they had been destroyed by a fungus disease (*Empusa grylli* Fres.). The disease had been observed in Natal several months before this. The same disease appeared elsewhere in the colony but proved destructive to the swarms only where the conditions of moisture necessary for the spread of such diseases obtained.

No official reports of ravages by this insect have been received by the Department of Agriculture for several months (up to January 1st), and it is sincerely hoped that the colony will escape a recurrence of last year's experience. The presence of small swarms about Port Elizabeth and in the sections of the colony east of that city have been mentioned in the newspapers.

An account of last year's invasion was published in the *Agricultural Journal* for June 25th, and notes on the fungus disease were published in the same number and in the issue for July 23rd.

Other Injurious Locusts —The smaller migratory locust, *Pachytylus migratorius*, often mentioned as the Old or Brown Locust to distinguish it from the Red-Winged Locust continues to be injuriously abundant in many parts of the Karroo. While on a visit to this section of the country, I gathered from many of the farmers that they experienced little difficulty in destroying the swarms which hatched on their lands while the insects were still very young, and that this species only continued to be injurious because of the negligence of some farmers who allowed the insects to develop unmolested on their farms. Little can be done against the locusts when once they have assumed the winged stage, and the matured insects migrate on to farms which have been cleared of the younger stages through the diligence of the owner and may there deposit their eggs.*

Spraying the young locusts at night with a contact insecticide is the favourite means to destroy them. Some farmers find it more economical to crush them with spades. The hard nature of the soil renders the pitting system and the collecting of the eggs less advantageous methods.

The eggs hatch shortly after the falling of rains. Near Graaff-Reinet, many small swarms appeared shortly after a rain in August; and other swarms appeared from the same places after the next succeeding rain which fell in late November. As no winged insects had visited the section during the period between the hatchings, it is believed that all the swarms originated from eggs laid at one time.

Near Cape Town, a little anxiety was felt among vine growers owing to the unusual abundance of locusts in their vineyards. These were of an indigenous species, *Acridium ruficorne*. Several Constantia vineyards have suffered from their ravages both during the season of 1895-1896 and the present season. The principal measure employed for their destruction is the keeping of flocks of turkeys in the vineyards. The birds quickly learn to feed upon the insects and prove a cheap and effective means of protection.

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* A reluctance to interfere with visitations of pests and plagues is strongly shown by the Dutch country-folk in many sections of the colony; these people assert that the visitations are sent by God as a punishment for their sins, and that to contend against them is to resist His will.

The eggs are deposited among the vines, but several extra diggings did not destroy them nor bury them so deeply but that great numbers of the young succeeded in reaching the surface.

Import Regulations.

The regulations at present in force restricting the importation of plants and their products are scheduled in Proclamation No. 107, 1896. The privilege of importing grape vines or portions or produce thereof is limited to the Government itself; and the introduction of any peach tree or other stone-fruit tree or any portion or produce of stone-fruit trees from the United States of America or the Dominion of Canada is entirely prohibited. With these exceptions, any tree or plant or fruit or vegetable product may be imported, providing it is found free of plant disease and insect pest. No declaration of any kind is needed except in the case of stone-fruit trees and parts or produce thereof, when a sworn statement to the effect that this was not grown in the countries from which the importation of these productions is prohibited is required. If any plant disease or insect pest is found, the landing (that is, the removal beyond the Dock property) of the article is forbidden until it is cleansed or disinfected in the manner prescribed by and to the satisfaction of the inspecting officer. The regulations do not apply to canned and preserved fruits.

The inspection at the different ports is at present entrusted to certain of the Customs officers; and the inspection at the Post Office is left to an officer of the Agricultural Department. At Cape Town, where the greatest number of the consignments are landed, the regular inspecting officer may ask that an officer from the Agricultural Department act as inspecting officer in any case where more technical knowledge of plants or insects than his is desirable. Likewise, the inspecting officers at other ports may forward specimens of suspicious articles for inspection. As entomologist, I have acted as special inspecting officer many times during the past year, and

hence make mention of this matter in my report, confining myself, however, to remarks relative to insects.

That imported trees be entirely free of insect pests is a matter of the greatest importance, for insects thus introduced into the country are very likely to stay and become extremely destructive. In evidence of this, it is only necessary to call attention to the scale insects considered in another part of this report. All of them are introduced species. The enforcement of the import regulations cannot be altogether efficient in preventing the introduction of diseases and insects, but it is an immense check. The difficulties attending the examination of a large consignment of trees at the Docks can only be appreciated by those who have made such examinations. Generally, the trees are packed in huge cases and have become much begrimed on the voyage, rendering it no easy matter to discover the presence of insects, which, when not present in numbers, might prove difficult to find even under far more favourable circumstances. There is always a possibility that some pest may escape detection although the probability is slight.

Among the insects which I have detected upon imported trees when acting as examining officer have been the Purple Scale (*Mytilaspis citricola*), the Black Scale (*Lecanium oleæ*), and a species of *Ceroplastes* on citrus trees from Natal; the Purple Scale, the Brown Scale (*Lecanium hesperidum*), and a species of *Dactylopius* on citrus trees from Las Palmas; the Purple Scale, the Brown Scale, and what appeared to be a species of *Chionaspis* on citrus trees from Brazil, and the Black Scale on citrus trees from Australia.

It is much more easy to detect the presence of insects on imported fruits for these are cleanly packed, and the colour of the insects contrasts strongly with the colour of the rind; or if the insect is within the fruit, there will usually be good surface indications of its presence. But the inspection is rendered tedious by the wrappings about the fruit, and the necessity of opening every case.

Most of the insects which may be introduced on fruit are scale insects or mites which affect the rind; and in the case of these insects, the chances of the infestation spread-

ing to plants and thus becoming established in the country are slight, though still of sufficient importance to be seriously considered. Most of the fruit is sold in the towns and cities, and the rinds eventually so disposed of that the infesting insects perish. But it must be remembered that many of these insects are capable of subsisting upon numerous garden plants, that eggs of the insects are often very numerous on the rinds, and that the young insects which hatch from these eggs are active. While there will be no evil from most of the rinds, a few are not unlikely to be thrown down in the proximity of some plant on which the insect may thrive. And from this plant the insect may spread unnoticed and slowly, and gradually become thoroughly established.

The insect pests which I found on imported fruits during the past twelve months were the Purple Scale, the Oleander Scale (*Aspidiotus nerii*), the Red Scale (*Aspidiotus aurantii*), the Mealy Bug (*Dactylopius sp.*), and *Parlatoria zizyphi* on lemons from the south of Europe; the Chaff Scale (*Parlatoria pergandii*), the Purple Scale, the Long Scale (*Mytilaspis gloverii*), and the Greedy Scale (*Aspidiotus camelliæ*) on oranges from Spain; the Long Scale on oranges from Port St. John's (Pondoland), and the Oyster-Shell Bark Louse (*Mytilaspis pomorum*) on apples from Tasmania. Of these insects, the Purple and the Long Scales are known in the colony only at a few places near Cape Town, and it is hoped that they will be eventually exterminated from these places. The Chaff Scale and *Parlatoria zizyphi* are nowhere known in the colony; the Oleander Scale is common, but unlike the type of the insect found in Europe, it is rarely seen on lemon trees. The Oyster-Shell Bark Louse has been found only on a few trees in the Eastern Province; these all came in one consignment from Europe, and have now been cleansed or destroyed.

The importation of lemons and oranges has been much greater this year than in the past, and very few cases have been examined without discovering scale insects. The Purple Scale has been especially prevalent. The Tasmanian apples which have been consigned here have nearly always been found infested by the Oyster-Shell Scale.

On several occasions, scale-infested fruit has been destroyed, but the consignees have usually been allowed to land it after having it washed in a solution of soft soap and water. This treatment as carried out was not always effectual in destroying all of the insects and their eggs, and now the removal of the scales after the fruit has been through the soap and water is demanded by the inspecting officer at Cape Town. If any scales remain of the fruit when it is presented for inspection, it is ordered to be re-washed and again scraped. Such rough treatment as this is, of course, ruinous to the keeping qualities of the fruit and entails considerable hardship on the consignees It is anticipated, however, that the merchants will profit by their experience and import only the best fruit, which in a measure will bring relief.

This country is not the only one which refuses to admit scale-infested fruit. In Western Australia, infested lemons are not admitted until after they have been kept immersed for an hour in a wash of one-third alcohol and two-thirds water. The import regulations of Western Australia are much more drastic than our own, and heavy charges are made for inspection. It is said that when the regulations were first enforced, most of the consignments of fruit had to be destroyed; but that after they had been in force for some time, only the best of fruit was received, and this was so carefully selected that almost every shipment passed the examination.*

Fumigation House.—The insects which infest imported fruit and plants could in many cases be easily destroyed by exposing the fruit to the fumes of some substance poisonous to animal life. The entire absence of any facilities for so treating articles has heretofore precluded the use of fumigation for this purpose at the Docks; but the Department of Agriculture has now had a small air-tight building erected close to the Searcher's office on the Dock property. This has just been finished, and has not yet been used. It was built in accordance with suggestions made by the entomologist, and will be described in

* See *N.S.W. Agricultural Gazette*, June, 1896.

some future publication when its practical utility has been fully demonstrated. As the chamber in which the fruit or plants will be exposed is almost absolutely air-tight, it is anticipated that hydrocyanic acid gas will suffice for destroying insects and their eggs,* but it is feared that the exposure will injure plants.

Nursery Inspection Bill.

Acting upon suggestions made early in the year, the Board of Horticulture recommended the drafting of a Bill having in view the prevention of the further dissemination of insect pests and plant diseases with nursery stock. The features of the measure desired by the Board were briefly stated, and a draft measure based upon these was prepared by the Department of Agriculture. When viewed in their amplified form, however, the features of the Bill were seen to be unnecessarily drastic, and the measure was consequently put aside. A draft measure on different lines, drawn up by the entomologist in conjunction with two members of the Board, was then proposed and accepted. This draft measure has been several times amended and revised, and is now awaiting publication. It is to be discussed by Parliament during the coming session.

The Bill provides for the registration of all nurseries of plants and trees, and for the regular inspection of these by a competent official appointed by the Minister for Agriculture. This inspecting officer is to proclaim under quarantine such parts of any nursery, lying within a prescribed distance of plants, which he finds infested with insect pests or plant diseases. But the terms "insect pests" and "plant diseases" are to be held to apply only to such insects and diseases as are brought under the Act by Proclamation by the Governor. The removal of any nursery stock from a quarantined area is to be illegal, and the quarantine is to remain in force until, at a subsequent inspection, the area is found to have been freed of the cause for it. One extra inspection, free of charge, and others to be paid for by the nurseryman, are provided for in case the

* This has subsequently been proved to be the case.

nurseryman desires to have the quarantine removed prior to the next regular inspection. If it so happens that dangerous pests of any kind not prescribed under the Act are found by the inspecting officer, this official is to destroy the infested plants if the nurseryman offers no objections; but if the nurseryman demurs, action in the matter must be postponed until the judgment of an impartial committee, appointed especially to deal with such cases, has been rendered. The decision of this committee is final.

The pests against which the measure is especially intended are the injurious orchard scale insects. The distribution of these is very largely through nursery stock, and the immense injury which they may cause in this country, the climate of which is particularly favourable for their welfare, makes a measure of this kind essential to the best interests of fruit culture. It is not intended to include among the prescribed insects or diseases such as it is practically impossible to keep from plants grown at a reasonable distance from infected centres, nor such insects as are not liable to be conveyed from the premises with the plants.

The measure will not come as a great hardship to the owners of large nurseries, who at present take care to keep their stock clean of pests. But it will seriously affect many small nurseries scattered about the country, which are at present veritable "hot-beds" of scale insects and allied pests; and also some reputable nurseries that are carried on in connection with municipal gardens. It generally happens that the trees and shrubbery in the gardens harbour pests to such an extent that some would also be present on nursery stock grown among them. But that these municipal gardens are so poorly supported financially that the curators are obliged to conduct a nursery business in order to meet their expenses, cannot be held as an argument against a measure which unfavourably affects such nurseries, by requiring the stock intended for distribution to be free of pests.

PART II.

SOME ORCHARD PESTS.

A POPULAR ACCOUNT OF SOME SCALE INSECTS

AND

OTHER ORCHARD PESTS,

ALL OF WHICH ARE

LIABLE TO BE INTRODUCED WITH YOUNG TREES FROM NURSERIES.

PLATE II.

Explanation of Plate.

1. Black Scale (*Lecanium oleæ*) on orange twig, natural size.

2. Brown or Soft Scale (*Lecanium hesperidum*) on orange leaf, natural size. The blackening of the leaf is due to the smut-like fungus which accompanies the attack of this and some other scale insects. The scales shown are not quite full grown.

3. Greedy Scale (*Aspidiotus camelliæ*) on apple twig, natural size.

3*a*. Female Greedy Scale, enlarged eleven times.

4. Purple Scale (*Mytilaspis citricola*) on orange leaf, natural size.

4*a*. Female Purple Scale, enlarged eleven times.

5. Red Scale (*Aspidiotus aurantii*) on pear twig, natural size. Observe the reddish discolouration about the scales, and that this extends into the tissues beneath, as shown where the bark is cut away.

5*a*. Female Red Scale, enlarged eleven times.

6. Red Scale and Long Scale (*Mytilaspis gloverii*) on a lemon, natural size.

6*a*. Female Long Scale, enlarged eleven times.

7. Oleander Scale (*Aspidiotus nerii*) on an imported lemon. The green colour about the scales is due to imperfect ripening of the rind.

7*a*. Female Oleander Scale, enlarged eleven times. The green is present to give relief to the whiteness of the scale.

UNIV. OF CALIFORNIA

Arthur Bock del. Cape Town, S. Africa

TO WHOM
ATTACH

Introductory.

The area under fruit culture in our colony is rapidly increasing, and so is the number and importance of insect pests of fruit trees. Chief among these orchard pests in our climate are scale insects, plant lice and their allies. These are pests of insignificant size, but pests which do an incalculable injury to trees by extracting their life juices. They are pests of the first importance to the fruit grower seeking to establish new orchards, for they may be unconsciously introduced with the young trees or with buds or grafts. No other insects are the cause of such frequent complaint to the Department of Agriculture, and in nearly every case the insects have become well established in the orchard before their presence has been recognised. Then it is a constant and expensive battle to hold them in check. Information on these pests of a fragmentary nature has from time to time been given to our fruit growers through the *Agricultural Journal*, but the need has been felt for a popular and more comprehensive article with illustrations. This it is now attempted to give.

As I have sought to impress both on the title-page and in the text, these are pests which are liable to occur on nursery stock, and hence liable to be introduced into the orchard with young trees. My reason for dwelling on this point is to emphasize the importance of carefully examining young trees to see that only perfectly clean stock is planted.

The first-class nurseryman endeavours to prevent infested stock from leaving his nursery; but, nevertheless, the stock from even the best nursery in this country or any other should never be accepted as clean until it has been seen to be so by personal examination.

The general plan followed in this paper is that set by L. O. Howard, the Entomologist of the United States Department of Agriculture, in "Some Scale Insects of the Orchard," which was published in the 1894 Year Book. The source of each illustration is acknowledged in the reference to it. Many, it will be noticed, are from the United States Department of Agriculture. These are from electrotypes obtained through the courtesy of Mr. Howard.

CHAS. P. LOUNSBURY, B.Sc.,
Entomologist.

Cape Town, March 10th, 1897.

SOME ORCHARD PESTS.

Classification of Pests Considered.

The myriad forms of life are classified by naturalists for convenience in study and reference. Animals are separated from plants as different kingdoms. The animal kingdom is divided into branches, these branches are divided into classes, the classes in turn are divided into orders, the orders into families, the families into genera, and the genera are finally divided into species.

The pests considered in this report fall under the branch Arthropoda. The majority belong to a sub-order of the order Hemiptera in the class Hexapoda; while the remaining few belong to different families in the order Acarina of class Arachnida. The members of the order Acarina are popularly known as "mites," but some of the larger forms are better known as "ticks."

The name Hexapoda signifies "six-footed," and this class includes those six-footed forms of life familiarly termed "insects." Strictly speaking, only members of this class are insects, but the name is often applied to members of the other classes embraced in the branch Arthropoda with the exception of the Crustacea. Some authors give ground for this wider application of the word by making a class called "Insecta," in which they place these other Arthropods; they then speak of the true insects as "six-footed insects." Under this broad meaning, mites and ticks, as well as spiders, centipedes, and certain other forms may be called insects, while under the restricted meaning, as the word is here used and as it is used by most modern writers, they are not entitled to the name.

The insects are divided into a large number of orders, the insects popularly designated as bees, beetles, flies, dragon-flies, locusts, and bugs, all belonging to distinct orders. As already stated, most of the pests to be considered belong to a sub-order of the Hemiptera, which is the

order of insects commonly called "bugs." In some countries, including this colony, this term of "bugs" has come into common use to designate a particular kind of bug which, from its unpleasant associations, forms so disagreeable a subject that it is desirable to avoid this name even when writing of insects to which it applies with perfect propriety. I mention this here to justify the appellation of "Mealy Bug," "Australian Bug," and the like. These names are used in this report since they have become generally adopted as the common names of the insects they designate. By many writers the general term "Scale Bugs" is used in the same sense that "Scale Insects" is here used; and were it not for the objection mentioned, the former term would be preferable, as it suggests the position of the family in the classification of insects.

The members of the family Hemiptera take their nourishment in liquid form by the aid of mouth-parts specially adapted for piercing and sucking. The family is divided into three sub-families, Parasitica, Heteroptera and Homoptera. The first includes the lice which infest the skin of mammals, and suck blood. The second includes numerous forms, many of which are notorious for the exceedingly foul-smelling liquid they are able to emit when disturbed; the so-called "Stink Fly," that sucks the juice of the tender twigs of citrus trees and many garden plants may be taken as an example. The third is made up of nine families, three of which include pests to be here discussed. The three are Psyllidæ or Jumping Plant Lice, Aphididæ or Plant Lice, and Coccidæ or Scale Insects. The general characters of each of these families will be given prior to the description of the pests included in it.

COCCIDÆ OR SCALE INSECTS.

Classification.

This family is not an extensive one, but it is a family of great economic importance. Its members are generally easily distinguished from the members of other families, but they exhibit a wonderful variety of forms among themselves. Naturalists divide the family into several sub-families, but notwithstanding many differences usually to be found between the members of these different groups, the characters by which they may always be separated cannot be given without entering into technical details which would be out of place in a popular treatise like this. Three of the sub-families, respectively, the Diaspinæ, the Lecaninæ, and the Coccinæ, are represented among the species here discussed.

The DIASPINÆ includes the greatest number. The members of this group are all very small insects, and are sometimes spoken of as "armoured" scale insects, for the reason that the adult female insect is protected by a shield-like covering. This covering or scale entirely conceals the body and is composed of a wax-like substance secreted by the insect. It is generally completely separable from the full-grown insect, although in many cases it develops beneath as well as above, and thus still retains the body when it is raised. As the young insect develops, it casts off its skin which remains attached to the forming scale. These cast-off skins are conspicuous on the scales of most members of this sub-family and their location varies in different genera.

The members of the LECANINÆ are, as a rule, larger than the members of the preceding group from which they are most readily distinguished by the absence of the shield-like covering. The upper surface of the body in many of the species becomes more or less hardened, and this character has led to this family being referred to as "naked" scale insects.

The COCCINÆ are mostly soft-bodied scale insects, and, as a rule, have little that is "scale-like" about them. The

majority of them secrete a considerable quantity of wax. This assumes various forms and shapes in different species; in some, it occurs as plate-like layers; in others, as meal-like powder; in still others, as a mass of threads; while it envelops others as a felt-like sack. The adult forms of some of the Coccinæ are easily confused with some of the Lecaninæ.

Life History.

The round of life differs materially in different species of scale insects, but all possess some characters in common not found among other insects. The adult female is always an entirely different appearing insect than the adult male. At birth, the sexes are much alike though distinguishable. Both are very small, naked, active

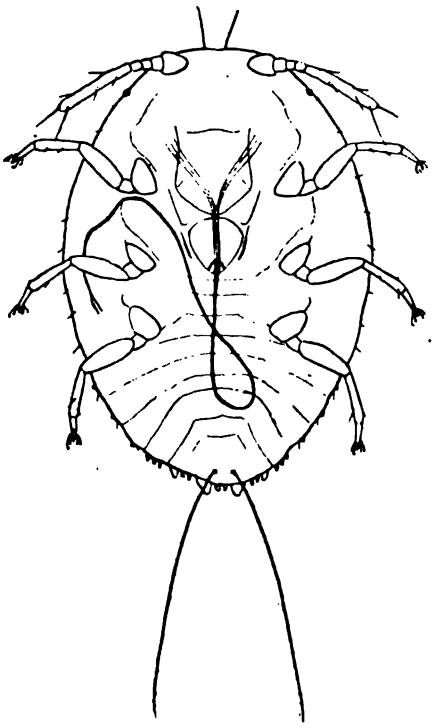

Fig. 1.—One of the Diaspinæ (Red Scale) a few hours after hatching. Note the well developed feet and sucking organ; the latter is shown exserted, but the organ is generally retained within the body until a feeding-place has been selected. (Adapted from a figure by A. Berlese.)

insects, which speedily find suitable feeding places, and, inserting their comparatively long and exceedingly slender "beaks," soon begin to suck the juices of the plant. As a general thing, the females cast their skins several times before reaching the adult condition. Their development differs greatly in the different genera. In the Diaspinæ and in most genera of the other sub-families, the legs cease to develop or are even lost, and the female loses all power to move about. The eyes, too, cease to develop and may be lost; and in some, the antennæ, as well. There is never any pupal stage nor development of wings, and the mouth-parts always remain functional.

The males, on the other hand, lead a different life after having partially developed. They assume a pupal state, from which they emerge as winged insects. Their mouth-parts are lost, but the other appendages are perfectly

Fig. 2.—Adult female of one of the Diaspinæ removed from its scale, an viewed from beneath. Note the absence of legs and the development of the bristle-like sucking organs; the latter are shown separated, but lie together when in use. (From U.S.A. Dept. Agr.)

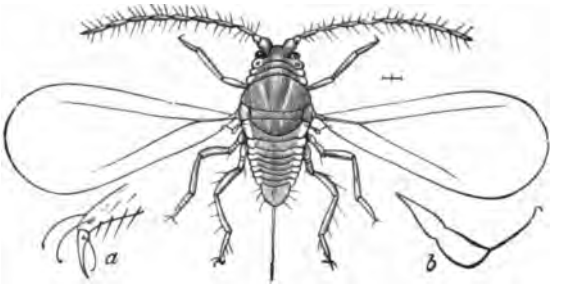

Fig. 3.—Adult male of the species of which the female is shown in Figure 1. (From U.S.A. Dept. Agr.)

developed; and they are provided with relatively large, compound eyes which are supplemented by one or more pairs of single eyes or ocelli. The wings are two in number and are longer than the body. As the males are not provided with any means of taking nourishment, they are short-lived, their sole function being to seek and fertilize the females. They are extremely small, even compared to the females, which are often no larger than the head of a pin; some males measure no more than a fortieth of an inch in length.

The number of eggs laid varies greatly among the different species. Some do not appear to lay more than thirty, while others deposit upwards of two thousand. The number of generations passed during a year also varies widely; it always appears to be at least one and sometimes as many as six. The eggs are laid by the female beneath her body or else behind it; in the latter case, they are protected by a covering of waxy secretion in some form. In some species, the eggs are hatched before they leave the body. The interval of time between the deposition of the eggs and their hatching varies greatly; while in some species, it is several months, in others, it is but a few hours or days.

How Scale Insects are Desseminated.

Primary Agencies.—As has been stated, the female insects pass their entire lives on their food plant, and in the majority of cases entirely lack the power to change their

positions. Therefore, if the tree or plant infested by these insects is transplanted, the insects also are transplanted. The moving of the plant does not destroy their vitality, and if the part of the plant they infest survives the change, they, too, will survive it, unless, perchance, care is taken to destroy them. Moreover, the insects are very likely to profit greatly by the change if they are removed to a place where their species has not long been established, for they will probably have left behind them numerous enemies which before served to check an abnormal increase on their part.

It should be observed that scale insects are not excessively destructive, as a general thing, under purely natural conditions, but become such when Man by his interference disturbs the balance which Nature in time had produced between them, their food plants, and their enemies.

Commerce between nations has developed wonderfully during the last few decades, and one of many benefits from this development has been the interchange of plants of all kinds. But beneficial as this interchange of plants has been, it has led to the dissemination throughout the world of many pestiferous insects. The interchange of plants still goes on and continues to increase, so that the dissemination of insect pests with plants is greater now than ever before.

The scale insects introduced from foreign countries, as a rule, first become established in the nurseries, as nurserymen are the chief importers of plants. The contiguous tops of the young trees in the nursery rows offer the best possible opportunity for the young and active scale insects to spread from one to another, and thus large numbers of trees become quickly infested, and these when they leave the nursery carry the pest with them. Thus the insects become disseminated throughout the country. On a smaller scale, the interchange of scions and cuttings between farmers and gardeners aids in the distribution of pests. The cuttings or scions may appear clean, and yet bear the early stages of some injurious scale insect.

Another probable factor in the spread of some scale insects is the careless disposition of infested fruit rinds. When it happens that any are cast down close to a food plant of the insect on the rind, there is nothing to prevent

the young insects from becoming established on the plant. This may occur in lands far distant from where the fruit was grown.

Secondary Agencies.—While scale insects are generally distributed to different sections of a country by nursery stock or cuttings of plants bearing specimens of the insects in some form or other, other agencies are active in distributing them locally. These other agencies are the wind and moving objects. The wind is the most important. Its direct influence is largely restricted to the larger species of scale insects, particularly to the larger Coccinæ. The spread of the Australian Bug through this country was no doubt much facilitated by high winds which tore the egg-laden females from their food plants and often carried them considerable distances. But, fortunately, few scale insects can be blown from their plants like this species. Among the agencies grouped as moving objects are moving water, insects, birds, and animals, including men.

It has been shown that young scale insects very frequently attach themselves to the lady-birds which prey upon them and are thus transported to other trees. These lady-birds, however, generally carry the scales but very short distances, as they themselves have no reason to migrate far from the plant where they have plenty of food, which must be the case where the young scales are abundant. The ants which frequent scale-infested trees have been found to transport young scale insects; but as ants appear to travel back and forth from their nests to the one tree, they probably serve only to scatter the scale insects more completely over the same tree. Other insects, also, must sometimes act as unconscious bearers, and the wind may still further contribute to the spread by influencing the flight of insects to which young scales are clinging.

Birds are said to sometimes carry scale insects in the same manner as insects, and probably do to a slight extent. But there are very few cases on record of birds having been observed to feed upon scale insects, and it is only rarely that scale insects occur on the upper surface of branches where birds naturally alight. In this country we have a small bird, the White Eye, which is reputed to prey

upon scale insects to a slight extent, and it is possible that it occasionally adds the unintentional carrying of the young of these insects to its other noxious practice of pecking ripening fruit.

Animals undoubtedly sometimes rub off the eggs or young of scale insects from the plants, and it is easy to believe that some of the insects become conveyed about on the fur and eventually reach a suitable food plant. But fruit trees are seldom found where cattle run in this country, and so it is highly improbable that our fruit scale insects are often carried to new situations by animals. Men working among the trees are more likely to sin in this respect.

Water in irrigation ditches is attributed with the carrying of the Australian Bug to places lower down the stream by many of our farmers, and there is no reason to doubt that the spread of this particular insect was in small part due to such means. Nor is there room for doubting that this same factor conveys some of our other scale insects about, but chiefly from tree to tree in the same orchard by floating along leaves and fruit which have recently fallen from an infested tree.

Although within the range of possibility, the chances are decidedly against the scale insects of the orchard being carried from farm to farm by the wind and the secondary agencies mentioned. Our farms, as a rule, are too widely separated by stretches of open country with vegetation upon which these scale insects cannot live. The Australian Bug is excepted in this statement, for it does find subsistence on a few veld plants. In towns and villages these secondary agencies play a more important part. Here ornamental plants and trees upon which the insects can subsist, if not thrive, unite garden with garden. But even under these most favourable circumstances, the spread of the insects through these agencies is apt to be very slow and largely a matter of chance; and cases are not infrequent where a few trees or a few gardens remain infested by scale insects for many years without the infestation being carried to other trees or gardens.

Influence of Climate on Scale Insects.

Extremes of heat and cold are alike fatal to most scale insects, and, consequently, we find them most abundant and injurious in the warmer temperate climates, where neither extreme is felt. In the colder climates like that of England and of the northern United States, few species are specially destructive in the open air, but a number are well-known for their injuries to plants in greenhouses. Those on plants out-of-doors remain dormant for several months during the cold half of the year.

The climate of this colony seems to be well suited to the requirements of most species. Those which most afflict us are species introduced from abroad. There are many species which are native to the country, but, fortunately for us, few of these have taken to cultivated plants. Our indigenous flora suffers more or less from their attacks, but as the insects are small and the manner of their attacking the plants not one which readily attracts the attention of casual observers, they are seldom noticed by farmers and little attention is given them. Nevertheless they abound in many sections. Even on the dry Karroo, several species are not uncommon on the veld bushes, and at least four occur on the Thorn Tree (*Acacia horrida*).

In cold climates, scale insects breed with more or less regularity, most of the insects of a given species in any locality all passing through the same stages of life together; this makes it possible to predict beforehand the date at about which the eggs will hatch. In warm climates like our own, where there is less distinction between the seasons, this uniformity in the life of the insects is wanting, and all stages of growth are usually to be found at any time of the year. In the vicinity of Cape Town, some species of scale insects breed uninterruptedly through the winter.

Food Habits.

Many species are restricted to a limited range of food plants, often to the members of a single genus or family, while other species are able to subsist upon almost any plant, exhibiting, however, decided preferences for a few

which may or may not be related. The food plants of some of the species varies to some extent in different countries; these variations have probably been brought about by gradual changes in the food instincts affected by changes in surroundings. The young insects must often wander or in some way be transported to plants upon which it is not customary for the species to live and possessing only limited powers of locomotion, they are forced to remain there. In the majority of cases such individuals perish without deriving any nourishment; in others, they manage to subsist for some time, but almost invariably succumb before reaching the adult stage. It is not unreasonable, to suppose, however, that in rare instances some insects thus unnaturally situated, do survive and produce offspring which inherit the parent's acquired habit of subsisting on this new plant. Or, occasionally, the plant from which they are thus compelled to take nourishment may prove well suited to their requirements. In either case a new food habit would be acquired. In its original habitat, the species may have long ago reached the limit in the number of plants suited to it among the plants there grown, but when introduced to new countries it may find new food plants and become gradually weaned, as it were, from some to which the species had been accustomed at home.

The fact that the food plants may thus vary has an economic bearing, since if these insects are brought into one country from another, they may bring with them food habits somewhat different from those of the same species already existant in the country; or if they are the first of the species to become established, they may become more destructive than in the country from which they came through adapting themselves to other plants.

The species which have become cosmopolitan, as a rule, are able to sustain themselves on many plants. To this property is probably due the fact that they have become widespread, since their chances of becoming established and subsequently spreading are greatly enhanced by a large number of food plants. But the increased commerce between countries is now gradually disseminating a number of very injurious species limited in their range of food plants.

Injuries Inflicted.

Direct Injuries.—All the scale insects derive their nourishment from the juices of the plant. When a few of the insects only are present, the loss to the plant is immaterial, but when they are present in great numbers, the plant suffers a great strain upon its resources. If the plant is already weak-growing from other causes, the injury from the scale insects is very apparent, but if it is otherwise in good health and well nourished, the effects produced by the scale may escape casual observation. In all cases, however, the plant is suffering from the loss, and in the case of fruit trees, will show it in the quality and quantity of the fruit produced.

It is not often that a tree will entirely succumb to the attacks of a scale insect except in much neglected gardens and old orchards where they suffer from other causes as well. The foliage may drop off, the twigs and even the branches die back, and the tree fail to produce any fruit at all, but as the roots remain healthy, the tree lives on, each growing season putting on a little growth.

The parts of the plant most affected varies with different species. Some show a marked preference for the fruit, others for the foliage and the young growth of wood, while a few abound from the collar of the tree to its utmost twigs. As a rule, the foliage of deciduous trees is not attacked, but there are many exceptions.

The foliage of some plants turns yellow in the vicinity of the scales, and in others turns reddish. Infested fruit is often malformed. In some cases, the scales on the fruit produce a reddish strain which discolours the surface about them, and extends into the tissues beneath. And a few species produce a similar stain on the bark and in the tissues of the wood. Lemons colour slowly in the vicinity of the Oleander Scale, so that green spots may mark the locations of scales of this species on otherwise yellow fruit.

Indirect Injuries.—Many of the Coccidæ exude honey-dew in common with certain other Homopterous insects. This honey-dew is a sticky, sweetish substance, and is the favourite food of many insects. But while much of it is removed from the plants by these insects, more or less of

it falls upon the foliage and other parts of the plant beneath the coccids that exude it. There it furnishes nutriment for the growth of certain fungi (*Capnodium*), the spores of which seem omnipresent. These fungi are very dark brown or black in colour and develop rapidly, soon giving the honey-dew bespattered parts of the plant the appearance of being covered with soot or smut. The breathing pores in the leaves become covered over, first with the honey-dew and then with the fungus, and thus the respiratory functions of the plant are deranged. The extent of the injury thus indirectly produced by some scale insects is considerable, but, fortunately, few of our common orchard scale insects in this colony produce the honey-dew.

Natural Enemies of Scale Insects.

Scale insects like all other insects have many natural enemies which prey upon them. The natural enemies of larger insects are for the most part birds and small animals, but scale insects are more preyed upon by members of their own class in nature, to wit—predaceous and parasitic insects. These natural checks on the increase of insects are necessary, for without them the insects would ultimately kill all of their food plants and then perish themselves. Often only a small fraction of one per cent. of the insects produced during a year are necessary for the continuance of the species without diminution in numbers;

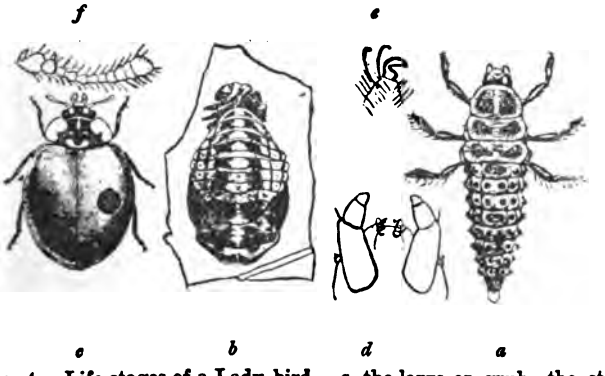

Fig. 4.—Life stages of a Lady-bird. *a*, the larva or grub, the stage after the egg; *b*, the pupa, the resting stage during which the transformation from grub to beetle takes place; *c*, the beetle or mature insect; *d*, the mouth parts of grub; *e*, claw of same; *f*, antenna of beetle. All the figures are much enlarged. (Adapted from U.S.A. Dept. Agr.)

and in the majority of species, the survival of one-tenth would lead to a tremendous increase. Except in one or two instances among the species here considered, the work of the natural enemies is decidedly insufficient to keep the insects from being destructive, and is seldom of such importance as to justify the non-use of insecticides.

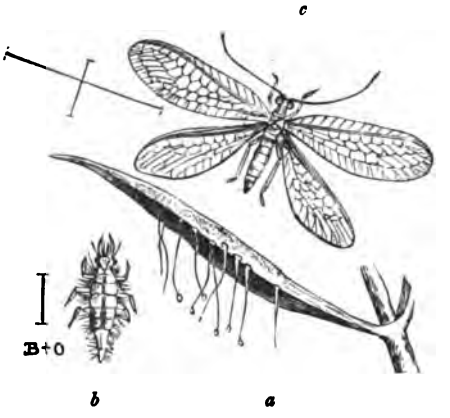

Fig. 5.—Life stages of a Lace-Winged Fly. *a*, eggs attached by their peduncles to twigs; *b*, the larva or grub, often spoken of as Aphis Lion; *c*, the perfect insect. The natural size of the larva and of the adult is shown by the hair-lines set against the respective figures. (From Miss Ormerod's "South African Insects.")

The most useful of the predaceous insect enemies of scale insects are included among the beetles popularly called "Lady-birds." Those observed to be of importance in this colony for destroying the different species are mentioned in the text. The larvæ of some of the Syrphus Flies, and the larvæ of the Lace-Winged Flies, those delicate, green, four-winged insects which possess a disagreeable odour, and which one occasionally sees about plants, also destroy some of the young scale insects. A few Hemipterous insects (bugs) have sometimes been noticed to pay attention to large scale insects, destroying them by piercing their backs with their pointed beaks and extracting the juices. Spiders, too, are said to sometimes occupy themselves at this useful work. The larvæ of some of the small moths have been observed in different parts of the world to prey upon scale insects. One species is men-

tioned in the text which preys upon the common Brown Scale.

The parasitic insects which destroy scale insects are very small, few of them measuring more than one-tenth of an inch in length, and many less than a thirtieth of an inch. In the mature state they have four wings. The larvæ feed within the body of the scale insect, and also upon the eggs. They transform to the perfect insect within the body, and finally emerge through round holes which they cut through the body-wall and through the scale if one is present. These internal parasites have not been studied by anyone in this country. They are not uncommon, one or two species attacking most of our common scale insects. Only rarely, however, have parasitized scales of the common Red Scale been observed in the colony. A very minute species is a common enemy of the White Peach-Scale, but though the parasitized scales are often far more numerous than the healthy ones, the scale continues to increase in numbers. Against the Black Scale there is a parasite which appears extraordinarily successful.

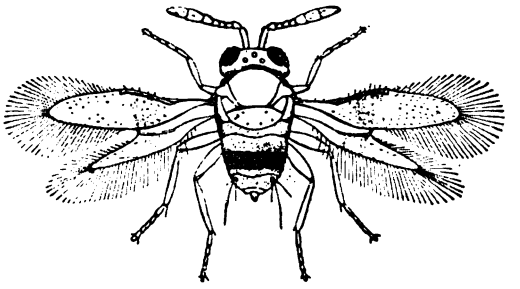

Fig. 6.—The mature insect of an internal parasite; this species, *Aspidiotiphagus citrinus* (Craw), is one which has been reared from the Red Scale in California. (From U.S.A. Dept. Agr.)

Few birds seem to care anything at all about scale insects. The only one which has achieved a reputation in this respect is the so-called White Eye (*Zosterops capensis*)* of this colony. This bird has been reported to me by different parties to feed upon the Australian Bug,

* It may be that more than this one species of *Zosterops* is concerned.

the Mealy Bug, the Oleander Scale, and the White Peach-Scale It is also said to attack aphides. Personally, I have only once observed it when it appeared to be destroying insects; in this case, it was pecking at something on the terminal twigs of a rose bush, and on examination no injury appeared to be done to the twigs, but numerous aphides were found to infest them. It would be interesting to study the habits of this bird, to ascertain whether or not it really does devour scale insects. It is possible that instead of scale insects, it feeds upon the lady-bird larvæ and other beneficial insects which are to be found among the scales.

The Red Scale.

(*Aspidiotus aurantii* Maskell.)

Names.—"Red Scale" is the generally accepted common name for this species, but to distinguish it from another reddish scale insect found on citrus trees in some countries, the qualifying clause "of California" is sometimes added. In Australia, it is sometimes mentioned as "Red Orange Scale."

Distribution.—The original habitat of this scale is still a matter of doubt and very likely always will be. It is recorded to occur in Southern Europe, Australia, New Zealand, Tahiti, West Indies, United States, Syria, Ceylon, and South Africa; presumably, it occurs in still other countries. Californians claim that it was introduced into their State from Australia; and W. M. Maskell, of Wellington, New Zealand, a noted authority on scale insects, considers it to have been brought to Australia from Europe, but the evidence is not altogether conclusive.

Occurrence in Cape Colony.—The Red Scale is wide-spread and destructive in Cape Colony. I have been unable to find any clue to the time or place of its introduction into this country, but its general occurrence in nearly all parts of the colony as well as in the neighbouring states would seem to be a good indication that it has been with us a

long time. Aged farmers claim to have known it in their boyhood, and an observant Cape Town gentleman, who has always taken a great interest in gardening, is positive that it was present on orange trees on his father's estate at Sea Point (near Cape Town) as far back as 1857. I have seen it in all of the dozen or more districts that I have visited, and have received it from at least a dozen others. But in many isolated orchards, it does not yet occur, although in a few cases known to me, the trees are upward of a hundred years old.

Fig. 7.—Red Scale, *Aspidiotus aurantii* Maskell. 1, scales on leaves of orange, natural size; 1*a*, adult male, much enlarged; 1*b*, scale of female, enlarged; 1*c*, scale of male, enlarged. (From U.S.A. Dept. Agr.)

Food Plants.—In California, the Red Scale is said to prefer citrus trees to all other plants, but to be occasionally found on numerous ornamental shrubs and trees growing in the immediate vicinity of infested citrus trees. (Coquillett.) In Jamaica, it is not found on citrus trees, but is common on *Lignum vitæ*. (Cockerell.) While in Queensland, Tryon

states that it infests not only citrus plants, but other kinds also, including the Mulberry, which succumbs to its attacks. Green states that it occurs on American Aloe (*Agave americana*) in Ceylon. In Cape Colony, it attacks and thrives upon a great number of plants, and during the past year I have noted it on all of the following:—Citrus trees of various kinds, Pear, Apple, Fig, Mulberry, English Walnut, Apricot, and Olive among fruit trees; Rose, Sweet Bay, and Privet among garden shrubs; Seringa, Blackwood, Bel Sombra, Willow, Carob, Keur-boom, Oak, Cypress, and Elm among shade and ornamental trees. This list is probably far from complete. The plants mentioned were not all badly infested, some bearing but few scales. The order in which they are placed corresponds with the severity of the attack, those first named in each class being most infested.

Citrus trees are preferred to other plants, and some kinds of citrus trees appear to be preferred to others, although no kind, as far as I have observed, is altogether exempt. Lemon trees suffer more severely than orange, and naartje somewhat less. In some orchards the Naartjes are quite free of the insects, when surrounding citrus trees of other varieties are badly infested. Here and there about the country one will find one or two citrus trees growing among others which, for some unaccountable reason, are almost exempt from attack; but these cases are exceptional.

The scales infest all parts of citrus trees, and are especially vigorous on the fruit. Both surfaces of the leaves are attacked. They are also partial to the young, green shoots, and are not infrequent on the rough, hard bark of older wood. The foliage often loses colour about the scales, turning from the natural dark green to a sickly yellow. Infested fruit is generally dwarfed, and on a feeble tree may dry up and crack. When attacked severely, the shoots lose their leaves and die back, thus, in turn, weakening the larger branches and affecting the whole tree, often to such an extent that it dies back to the main limbs. New shoots usually break out during the next growing season. These grow rapidly and give the tree an appearance of renewed vigour. But sooner or later these new shoots in turn succumb to the scale insects, and the dying back pro-

cess is repeated. This process may go on for many years before the tree finally succumbs, but such a tree can mature little, if any, fruit.

Trees that are in poor condition from other causes appear to be most injured. Apparently vigorous, strong-growing trees, however, often become badly infested; considering which, it seems anomalous that trees in poor condition and thickly covered with the scale will to a large extent become free of it when suddenly forced into rapid growth by the liberal use of fertilizers and improved treatment, even a copious application of lime to the soil having effected this result. This has been the case in several orchards which have come under my observation. How lasting these beneficial results will be, I dare not hazard an opinion. As

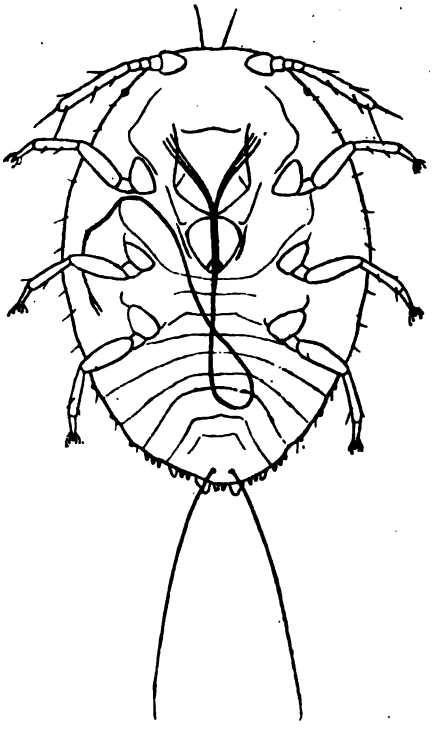

Fig. 8.—Red Scale, *Aspidiotus aurantii* Mask. Young insect less than twelve hours from hatching; much enlarged, the insect measuring about $\frac{1}{110}$ of an inch in length. (Adapted from A. Berlese.)

the scale thrives well in other orchards that are well nourished, it seems to be probable that the remarkable decrease in the number of the scales must be due to the sudden change in the condition of the tree.

Next to citrus trees, Roses are perhaps the most common sufferers from the attacks of the Red Scale, and few gardens about Cape Town do not bear witness to its injuries on these plants. In an exceptional case, a long hedge of Roses growing in a garden was seen to have been entirely destroyed by it, scarcely any of the bark not being coated with old and dried scales. Poorly kept gardens are always the worst infested.

Pear, apple and fig trees are all occasionally very badly infested and even killed. Infested fruit from all three were on sale in Cape Town fruit shops during the past year. However, trees badly attacked are nearly always growing in old gardens, in neglected corners of the orchard, or in unfavourable situations, as, for instance, in the shade of other trees. The exceptions which have been noticed were mostly young or newly-grafted trees, but not always; in one case at least pear trees that appeared to be well cared for, dying off from this cause alone. These trees were not of any one variety, but included the Duchess, the Marie Louise, the Calabash, the Bergamotte and others.

The other fruit trees mentioned in the list of food plants are seldom more than slightly infested in this colony as far as noticed. In one case only were Olives seen to bear the scale, but Olives are little grown here. It is mentioned above that Mulberry is sometimes very badly infested in Queensland, and a case is on record of an English Walnut in California being much infested. The Grape is not mentioned in the list, but now and then a stray scale is seen on it.

When this scale infests the young wood of Rose, Apple and Pear, the bark immediately around the scales and the tissues of the plant beneath become stained to a reddish colour. This stain is not always produced, but is usually present on Pear and Rose. It is well illustrated on the coloured plate accompanying this report. The fruit of the Apple and of the Pear is similarly discoloured in many cases from the same cause.

Badly infested Sweet Bay and Privet shrubs are to be seen in many gardens. Seringa trees (*Melia azedarach*) are sometimes a mass of this scale, bark, foliage and fruit alike being infested. The Oleander Scale is often associated with the Red Scale on this tree. Blackwoods (*Acacia melanoxylon*) are much infested in some localities, as in Uitenhage; and in the same town, as well as elsewhere, Bel Sombra trees (*Phytolacca dioica*) are attacked, the infestation even extending onto the fruit. Carob trees (*Ceratonia siliqua*) are not very common, but I have found infested young trees, only a few months out of the nursery, on Karroo farms. Orange trees growing close by were not infested, and the farmers had ceased to bring any citrus trees on to their places for fear of introducing this self-same scale among their trees.

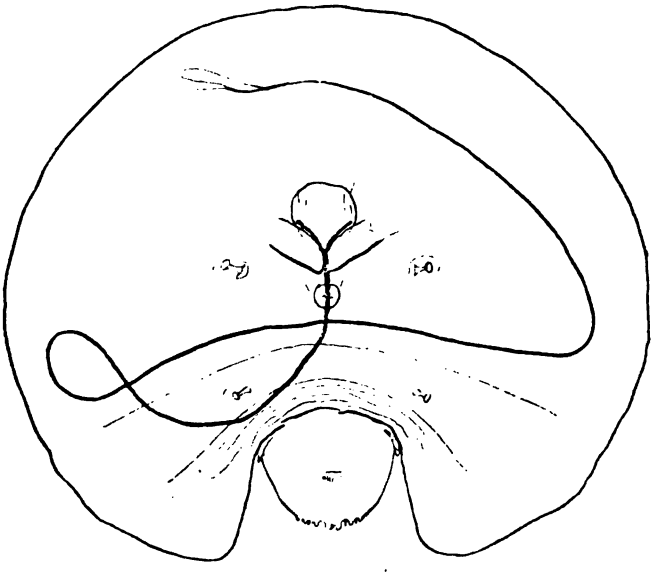

Fig. 9.—Red Scale, *Aspidiotus aurantii* Mask. Adult female, removed from scale; much enlarged, the insect measuring about $\frac{1}{20}$ of an inch in width.

The Willow is one of those trees which seem to suit almost any insect, so it is not surprising to find the Red Scale on it. Infested Oaks have been seen in the neighbourhood of infested apple and citrus orchards; the

infestation has never been severe in observed cases. The same statement may be made with reference to the Keurboom (*Virgilia capensis*). Cypress trees (*Cupressus macrocarpa*) standing in old gardens are sometimes attacked, above 150 scales in one case being counted on a single cone. The Elm is not a common tree in the colony, and only three trees have been found infested by this scale.

Description.—The scale of the female insect is nearly circular, and about one-twelfth of an inch in diameter. It it quite flat. Neur the centre is the remains of the first larval skin, technically known as the exuvia or pellicle. It shows as a bright, nipple-like prominence. The scale itself is translucent and greyish, but the insect beneath makes it appear in most cases to be a bright reddish-brown, the true colour of the scale showing only at the margin. Beneath the insect is another scale, the ventral one, which late in life becomes united with the upper or dorsal one. The insect is thus securely enclosed and is not easily removed. Early in life the insect is yellow in colour, but with advancing age it becomes brownish. It is almost circular in outline, but apparently cleft at the posterior end; this may be observed through the scale.

The male scale is less than a third as large. It is longer than wide, and the nipple-like prominence is in the front of the middle. The male scales are scattered among the female, and are easily found. When mature, the male escapes from its scale as a winged insect. The general characters of both male and female insects are discussed in the introductory chapter.

The Red Scale is one of those insects in which the eggs hatch within the body of the mother, or within a very short time after they are deposited. There is little regularity in the production of the young, and no marked interval between broods; but it has seemed to me that young scales have been most abundant from December to March. The number of generations which may be produced during a year has not yet been accurately determined. A tree was kept under observation through the past year, and while young scales were almost always present, they

seemed to be especially abundant during four periods. This probably indicated four generations. Specimens of the insect were once colonized on orange trees in the breeding-room of the Department of Agriculture at Washington, U.S.A., and it was observed that the lifetime was a little more than two months. From this it was inferred that at least five, and possibly six, generations occurred in the open air of Southern California. From personal observations made in California, Coquillett concluded that in ordinary seasons at least four generations were produced, and the same writer states:—"The adult female deposits eggs, but these are in such an advanced stage of development that they usually hatch out within twenty-four hours after being deposited."

Enemies.—Perhaps somewhere in the world the Red Scale has natural enemies which keep it reduced to the point where we would cease to consider it a bad best, but the existence of such an enviable spot is unknown to me. As Australia furnished the Vedalia which did such wonderful work in clearing several countries of the destructive Dorthesia or Australian Bug, and is a land noted for its number of different species of lady-birds, that country was searched to find efficient enemies of the Red Scale. But from Australian reports one cannot but conclude that this scale is almost if not fully as destructive there as here; and the lack of success in California which has followed the colonization of several species of Australian lady-birds which feed upon the scale is no encouragement to the hope that these natural enemies would do better when removed to another country.

In this colony we have at least four species of Coccinellidæ which prey upon the Red Scale, but none of these is restricted to this one food. They are, moreover, all small insects, and seldom abundant enough among the scales to be of any great service in destroying them. Full descriptions of these lady-birds will not be given, but common names suggestive of some conspicuous character will be assigned to them. They are *Pharus sexguttatus*

Gyllh.,* *Lotis neglecta* Muls., *Oenopia cinctella* Muls., and *Exochomus nigromaculata* Goeze.=*auritus* Scriba. The first we will christen the Six Spotted Lady-bird, in deference to the scientific name. The colour of this insect is a dingy black, and there are three reddish spots on each wing-cover. It measures about one-tenth of an inch in length. The second we will call the Four Spotted Lady-bird. This is a smaller beetle than the previous one. It is also black with red spots on the wing cases, but in this case there are two on each, and these are relatively much larger. The third will be named the Yellow Lady-bird. It is one-fifth of an inch in length and has yellow wing-cases margined with a narrow strip of black. The fourth is, it appears to me, the most useful lady-bird that we have in the colony. It is round and very convex, and in size stands between the Six Spotted and the Yellow, measuring about one-seventh of an inch. It is black with a yellow spot on each side of the thorax. For our purpose, Shining Black Lady-bird will be a good name.

One or more species of these lady-birds is present on almost every tree infested by the Red Scale. The two smallest seem to do the most good. The Yellow Lady-bird is frequently very common on the trees, but it is only rarely that I have seen it actually feeding on the scale. Both this and the Shining Black Lady-bird seem more partial to aphides. It is possible that more of our common lady-birds feed upon the Red Scale, but these are all that I am positive of at present.

In California, six species of internal parasites have been bred from this scale. [Howard, Insect Life, Vol. VI. p. 228.] Here, I have seen very few scales which appear to have been parasitized and have not yet secured any of the parasites. In Queensland, it is noted that a fungus disease destroys some scales.

Remedies.—All who have had experience in combating the Red Scale will agree that it is not an easy matter to clean an infested tree, and yet compared with many other

* The first three species were determined by E. A. Schwarz, Asst. Ent., U.S. Dep. Agr.; the fourth, at the South African Museum.

scale insects, this one is comparatively easy to contend against. The truth is that nearly all scale insects are very difficult to get rid of when once they are established.

The most successful remedial treatment is fumigation with hydrocyanic acid gas. This treatment is applicable on trees up to twenty-five feet in height; higher trees may be treated, but the operation of covering them is difficult.

Following fumigation, the next best treatment that I can recommend is thorough spraying with hot resin wash. Two or more sprayings are necessary, and in the majority of cases, the treatment will need to be repeated after six months. With faultless spraying, small trees may remain quite free of scale for one or even two years. The preparation and use of resin wash is discussed under another heading.

Various other insecticides are recommended and used, but I know of none to compare with resin wash in efficiency in dealing with the Red Scale. Paraffine emulsion and the carbolic sheep dips are useful, but in my experience they destroy few of the adult insects. They do destroy the young, and hence, if their use is persevered in, success eventually follows, but it is generally dearly bought.

The use of starch against the Red Scale, in the proportion of 2 pounds to 16 gallons of water, was mentioned in "Insect Life [Vol. II. p. 353] as a remedy used by an Australian with much success, it being stated that in a few days after the application the starch come off in flakes, "bringing the scales with it, and leaving the leaves and fruit as bright and clean as if they had never been infested with scale insects". As several parties in this country had informed me that they had used starch with excellent success against scale insects, I gave the substance a good trial on some badly-infested orange trees. Little benefit was derived from the application containing 1 pound of the starch to 16 gallons, nor from that containing 2 pounds to 16 gallons; but when the amount of starch was again doubled, the effect was very much as described, but not more than one-half of the scales came away. The starch peeled off slowly, and traces remained for at least six weeks. The foliage was wonderfully bright and clean afterwards, and, later, blossoms appeared, for the first time, I was told, in

several years. The scales that remained, however, were none the worse for their temporary starching, and at the time of writing, six months from the date of the application, the trees are again suffering severely from the insects. The starch was first mixed in cold water, and when a smooth paste had been made, boiling water was added.

Certain Californian parties during the past season have experimented with steam as an insecticide against the Red Scale, and they report good results. The trees are covered, and the temperature beneath the covering raised to a point destructive to the scales while not to the foliage. Certain obstacles, I believe, have to be overcome before this process is practicable, as compared with the hydrocyanic acid gas fumigation. But, even when the process is perfected, I doubt if it can be carried out in this country more economically than the gas treatment.

The Oleander Scale.

(*Aspidiotus nerii* Bouché.)

Names.—The common name by which the insect is here called is taken from the scientific name, *Nerium* being the name of the genus of plants to which the Oleander belongs. It is sometimes called the White Scale because of its colour, and in some works, it is mentioned as the Lemon Peel Scale from its frequency on the rind of this fruit. These names illustrate the confusion which common names may lead to. The name "White Scale" will apply equally well to many other scale insects, and this is only one of several which may attack the fruit of the Lemon. Of the three names, "Oleander Scale" is preferable because of its derivation, but as several other scale insects attack the Oleander, it, too, is open to objection.

Distribution.—The Oleander Scale is thought to be of European origin. It is now widely distributed throughout Europe and the United States, is recorded to occur in several of the Australian Colonies, in New Zealand and Chili, and is our most common scale insect in South Africa.

Occurrence in Cape Colony.—Plants or trees infested by this scale probably occur in all parts of the colony. In all likelihood it was introduced at an early date on Oleander, and has been carried from district to district and from farm to farm on this ubiquitous plant. Nevertheless as with the Red Scale, there are many farms yet free from it, and which may long remain so if proper care be exercised in the introduction of growing plants and fruit.

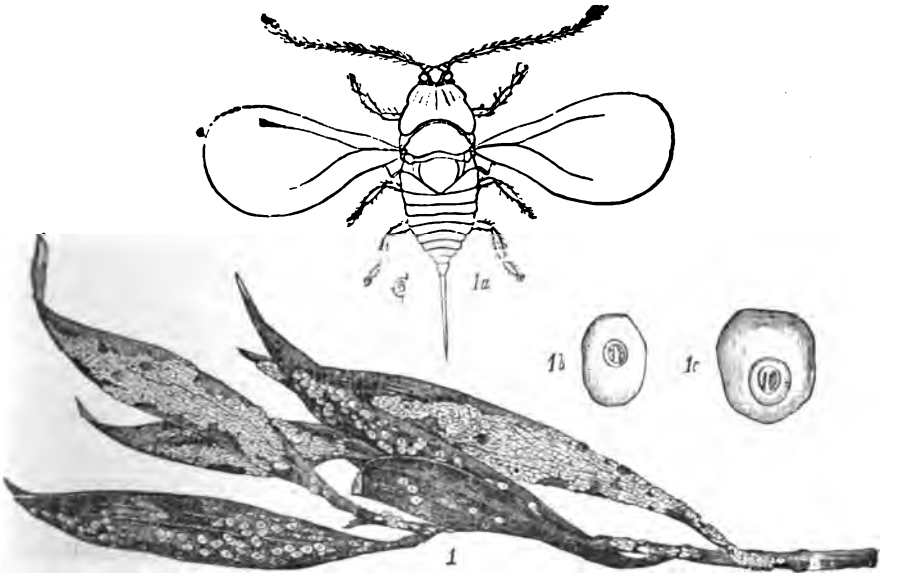

Fig. 10.—Oleander Scale, *Aspidiotus nerii* Bouché. 1, scales on leaves of Acacia, natural size; 1*a*, adult male, enlarged; 1*b*, scale of male, enlarged; 1*c*, scale of female, enlarged. (From U.S.A. Dept. Agr.)

Food Plants.—A complete list of the plants upon which the Oleander Scale has been reported to have been found, would be a very long one. Fortunately, it thrives upon comparatively few plants of the Order Rosaceæ, to which belongs the majority of our common fruits. During the past year, I have collected it from Lemon, Plum, Mulberry, and Fig among fruit trees; from Seringa, Port Jackson Willow, Black Wattle and other Acacias, Bel Sombra, and Kafir Plum among ornamental and shade trees; from Oleander, American Aloe, Hakea, Honeysuckle, Cape

Jessamine, English Ivy, Cape Gooseberry, and Carnations among garden shrubs, creepers, and flowering plants. In the United States, in addition to many of the plants already mentioned, it is recorded from Cherry, Orange, Olive, Currant, Maple, Magnolia, Yucca, Arbor-Vitæ, Oak, Lilac, and several herbaceous plants.

Lemons imported from the south of Europe are nearly always more or less infested with this species.* Such fruit generally ripens imperfectly, the rind about each scale remaining green as illustrated on the coloured plate. Considering the commonness of this scale in the colony, and on European lemons, it seems remarkable that it is not far more common on our lemon trees. Complaints of it on this tree have reached me but from two places, one in the Hex River Valley, and the other in Uniondale. Some of the trees at the Hex River orchard were very badly infested, the rind of much of the fruit on some of the trees being entirely covered with the scales. I have seen very few scales of this species on Orange, but this tree is given among the food plants in some American publications. [See Saunder's "Insects Injurious to Fruit."]

The common occurrence of this scale within the colony is a poor argument to advance against the present import regulation that requires its absence (in common with all pests) from imported trees and fruit. It has been stated that it infests imported lemons to a large extent, but is known in very few lemon orchards in the colony. This may not unreasonably be taken to indicate that while the true *Aspidiotus nerii*, the colonial form of the insect has ceased to infest the Lemon, or *vice versâ*, that the European form has added Lemon to its food plants; and in either case, that if the Lemon-infesting type is allowed to be brought here, the insect may become as well established on Lemon with

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* Since this report went to press, I have begun to suspect that much of the white scale on European lemons is not *Aspidiotus nerii* but *Aspidiotus limonii*. Both of these scales occur in Southern Europe but the lemon tree is not given by Signoret among the food plants of the former while it is given as the chief food plant of the latter. In appearance the two insects closely resemble one another. That *A. nerii* is fonnd on European lemons is stated by Comstock and this determination was given to me by Howard for scales on both European and Colonial lemons.

us as it is in Europe. The fact that the food habits of an insect may be different in different countries is well established. The Red Scale, so common with us on citrus trees, is said not to be found on these plants in Jamaica, but to occur on Lignum-Vitæ. [Insect Life, Vol. VI, p. 101.]

Plum, Mulberry and Fig are not common food plants for the insect, and I have rarely seen infested trees, except near infested plants of other kinds. The insects apparently thrive well, however, and often menace the health of the trees.

Seringa trees (*Melia azedarach*) are often very much infested; many trees have been observed which bore scales from the collar to the tips of the outermost twigs, as well as on both surfaces of the foliage and on the fruit. At Graaff-Reinet, some of the streets are shaded with Seringas, the young growth of which is quite white with scales. Many of these trees are periodically cut back to the trunks and main branches simply, so I was informed, to temporarily relieve the trees of the scale insect.

Port Jackson Willow (*Acacia saligna*) is a favourite food plant, as is, also, the Black Wattle (*Acacia decurrens*). The latter tree is grown to some extent for its bark which is used for tanning purposes. A piece of bark which measured fully a sixth of an inch in thickness, was recently sent to this office from the Forest Department as an illustration of how subject this tree is to the attack of this scale; the whole surface was quite covered.

Oleanders are very common ornamental shrubs in the colony, and as a rule, are slightly infested. Several hedges of American Aloe (*Agave americana*) about Cape Town are literally white with this scale. Farmers who grow this plant, should take care to keep their farms free of the insect. Hakea hedges about railroad stations and in the towns are frequently troubled. Carnations are sometimes destroyed by it, and on this plant it appears that the scale causes a reddish discolouration of the underlying tissues and surrounding surface, very much as the Red Scale does on Pear. This discolouration, however, is not always present, and is always most conspicuous at the nodes; it may be that it is only indirectly caused by the scale insect.

Description and Habits.—The scale of the female insect is snowy white, but before the insect is fully developed, it may have become less bright in colour, and nearer to grey than white; the change may be owing to exposure. The scale is nearly circular, almost flat, and about one-twelfth of an inch in diameter. The remains of the larval skin are near the centre; this in young insects is of a distinct yellow colour, but in the old, may offer little contrast to the rest of the scale. The insect beneath the scale is yellow, and may be exposed by simply raising the scale. The scale of the male is about half as long as that of the female, and of the same snowy whiteness. The breadth is less than the length. When mature, the male, like the males of other coccids is winged.

The Oleander Scale is recorded by Comstock to be an egg-laying species. When searching for eggs, I have seldom found many under a scale, but have often found young insects, which may be taken as an indication that the eggs hatch shortly after they are deposited. Coquillett states that he observed a living young issue from the body of a female which he happened to be examining under a microscope. [Bulletin 26, Div. of Ent., U.S. Dept. Agr., p. 21]. The number of annual generations does not appear to be recorded. Comstock supposes that two or more are developed.

Enemies.—The Six Spotted Lady-bird is a common enemy of the Oleander Scale. Often as many as two dozen beetles have been counted on a single leaf of the American Aloe; but even this number is entirely inadequate to keep the scale in check. Doubtless other species of lady-birds prey upon the scales, but thus far, I have not observed them. Internal parasites are responsible for the destruction of great numbers. One species reared from scales on lemons from the Hex River orchard referred to, was identified by Howard as *Aphelinus diaspidis* How. From statements made by Coquillett, it appears that internal parasites of the scale are not common in other countries. French, however, mentions that some scales are parasitized in Victoria. The bird called "White Eye" (*Zosterops capensis*) is said to destroy some scales on Seringas at Graaff-Reinet.

Remedies.—The Oleander Scale is combated by the same means as the Red Scale, but it appears to be destroyed with greater difficulty than that scale. However, it will yield to hydrocyanic acid gas and to resin wash. As the fruit is particularly subject to the scales, it is best to spray after this has been gathered or at the season when there is least on the trees; the scales on the fruit are more difficult to destroy than those on other portions of the trees. Deciduous trees are easiest to treat when the leaves are off, and stronger insecticides may then be used than when foliage is present.

The Greedy Scale.

(*Aspidiotus camelliæ* Sign.)

Name.—The name "Greedy Scale" has reference not to an abnormal appetite on the part of the individual insect, but to the propensity of the species to infest a great variety of plants.

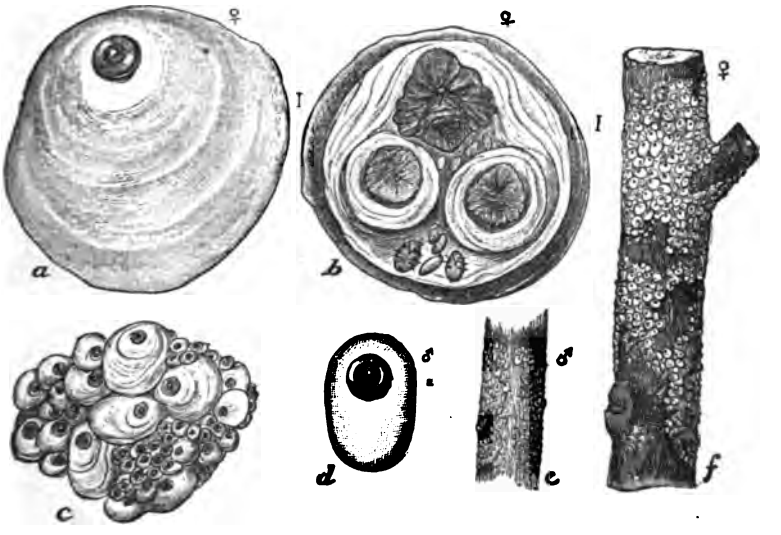


Fig. 11.—Greedy Scale, *Aspidiotus camelliæ* Sign. *a*, female scale from above; *b*, same from below; *c*, mass of scales as appearing on bark; *d*, male scale; *e*, male scales on twig; *f*, female scales on twig; *e* and *f*, natural size; *e*, much enlarged; *a*, *b*, and *d*, greatly enlarged. (From U.S.A. Dept. Agr.)

Distribution.—The Greedy Scale is said to be of European origin. Howard states that he is inclined to believe that the species is native to south Europe and has been carried by commerce to Australia and New Zealand, and thence to California, from whence it has spread to other portions of the United States. [U.S. Dept. Agr. Year Book, 1894, p. 262.] It has also been found in Ceylon, the Sandwich Islands, and in England, and it is now my unpleasant duty to record its presence in Cape Colony.

Occurrence in Cape Colony.—No clue has been found as to the time and place of its introduction into Cape Colony. As yet not many occurrences are known, but it has been found at Graham's Town and Port Elizabeth, and at various places in the Cape, Stellenbosch, Paarl and Worcester Divisions. Twice during the past year it has been forwarded to the Department of Agriculture, once on Guava and once on Pear. It does not seem to be a widely disseminated nor serious pest, but to judge from the experience of other countries, it is one which may give us much trouble at some time.

Food Plants.—Thus far, the Greedy Scale has not been found upon many kinds of plants, but among the trees upon which it has been noticed are Pear, Apple, Guava, Fig, Silver-Tree and Blue Gum; and among other plants are English Myrtle, Veronica and Golden Feather. It has also been found to a slight extent on Grape. In Europe, it appears to be a frequent pest on Camellia, from which plant the specific name is derived. Coquillett states that in California he has taken full-grown specimens from the following plants: Apple, Pear, Loquat, Myoporum, Birch, English Laurel, Maple, Silver-Tree from South Africa, *Rhamnus croceus*, California Walnut, English Holly, Fuchsia, Cottonwood, Camellias from Japan, also on oranges and lemons. [Bull. 26, Div. of Ent., U.S. Dept. Agr., p. 25]. To this long list may be added the following plants previously recorded by Comstock: Almond, Quince, Willow, Eucalyptus, Acacia, Locust, Olive, and Mountain Laurel (*Umbellularia californica*) in California, and *Euonymous japonicus* in Florida; to the three plants last

named, the scale is said to be very destructive in some localities. [U.S. Dept. Agr. 1880 Report, p. 308.] Green states that in Ceylon it is a serious pest on Tea and that he had seen a Cinchona tree dead from its attacks. [Coccidæ of Ceylon, Part I. p. 45.]

As already stated, the insect does not yet appear to be a serious pest in this colony; however, apples and pears exposed for sale in Cape Town fruit shops are not infrequently disfigured with its presence. Old apple and pear trees about Cape Town are generally infested to at least a slight extent, but in most cases, the infestation is limited to the twigs and fruit. The twigs are sometimes quite covered with the scales during the winter. Green figs, bearing scales, have several times been purchased in fruiterers' shops; and numerous scales have been observed upon the young wood and foliage of fig trees. Guava appears to be a favourite food plant, but I do not know of any trees which have been greatly injured. Silver-Trees in several gardens have been observed to be seriously injured. The seed capsules of the Blue Gum (*Eucalyptus globosus*) from trees growing in many parts of the Cape Division are sometimes completely coated over with the scales, while on other parts of the trees, the scales are of uncommon occurrence.

Description.—As in closely allied species of scale insects, the scale of the female is nearly circular. The actual colour is often disguised by particles of dust but is yellowish in clean scales covering living insects and grey in those covering only dried remains. The enclosed insects are yellow. When the upper scale is torn away, a thin, pure white under-scale, closely adherent to the surface of the plant, is exposed. The upper-scale is very convex, and the cast-off larval skin is situated near to one end instead of near the centre as in the Red Scale; the prominence thus formed is very dark in colour, usually with a white centre and bordered outwardly with a white circle. Comstock and Maskell agree in stating that the scale of the adult female measures one-fifteenth of an inch in diameter. The scales of specimens found in this country, however, are all of one-twelfth of an inch.

I have seen very young larvæ beneath the scales, but have not seen eggs except within the body of the female. Comstock states distinctly that the eggs are yellow, and as Howard makes the same statement and further figures eggs, there can be no doubt that there is, at least, a short egg stage.* No studies to ascertain the number of annual generations have been recorded.

Oranges and lemons, according to Coquillett, are sometimes thickly infested with scales of this species, but this seldom happens except when the fruit is allowed to hang on the trees for several months after ripening; "in such cases," adds this writer, "I have never found any of these scales upon any other portion of the tree." No infested oranges or lemons have been observed in this country, but imported Spanish oranges have now and again been found to carry a few of the scales.

The insects appear to be most partial to the fruit, the young, all or nearly all, migrating to it if it hangs upon the trees for an extended period. This habit may aid in the dissemination of the insect to other locations, but it undoubtedly tends to decrease its multiplication, inasmuch as myraids of the insects perish on the ground and with the fruit.

Enemies.—No parasitized specimens have been observed among a great number examined on Blue Gum, and very few have been noticed on the other food plants about Cape Town; but scales on a few young Guavas grown in an Eastern Province nursery and planted out in Stellenbosch, were found to be nearly all parasitized, a minute aperture in the top of the scale testifying to the escape of the parasite. No lady-birds have been found in the act of destroying scales of this species, but on Pear and Apple, scales have several times been found, torn in a manner which

* Howard, however, remarks that the insect appears to hibernate indifferently in the egg state, as adult female or as young, from which it must be inferred that a long egg state has been observed. That there should be an egg state is not in accordance with the idea advanced by E. E. Green (Ent. Month. Mag., Apr., 1896, p. 86) that Diaspinæ lacking spinnerets (as does the present species) are ovoviviparous.

seemed to indicate that these most beneficial beetles had feasted on the former occupants.

Remedies.—In spraying against this species, particular attention should be given to the twigs. Deciduous trees, of course, should be sprayed during the winter; and resin wash or lime-sulphur-salt wash might be used. Trees which hold their leaves should be treated with the resin wash.

The preference shown by the scales for the young growth increases the chances of introducing this species into orchards with scions for grafting. The tree from which the scions are taken may appear clean from an examination of the stem and branches, all of the scales being confined at the time to the terminals.

A large number of Apples and Pears, recently planted out in Stellenbosch orchards, are infested by the Greedy Scale. Only a few are generally present on a tree, but this gives no assurance that it will not multiply and become exceedingly troublesome. The owners of Stellenbosch orchards should keep a sharp watch on this species and stamp it out wherever possible. The form and colour of the scales render them easy to discern on the bark.

The Purple Scale.

(*Mytilaspis citricola*, Packard.)

Names.—Some writers have called this insect "Mussel Scale," and others "Orange Mussel Scale," but as an allied insect, *Mytilaspis pomorum*, is frequently called Mussel Scale, the older name of Purple Scale is here adhered to, although it is, perhaps, less suggestive of the insect.

Distribution.—The Purple Scale was described from specimens collected in Florida; but United States entomologists do not believe the species indigenous to their country. A note in "Insect Life" states that it probably came from China [Vol. VII., p. 429], and an earlier note by another party in the same journal suggested the West Indies as its home [Vol. V., p. 203.]. But wherever it came

from originally, it is now to be found in almost every country in the world where oranges are grown. It appears to be the most common of the citrus tree scales in Southern Europe, and is reported from Russia, Ceylon, the Fiji and Sandwich Islands, and from many of the West Indies. Trees arriving at Cape Town from Brazil have been badly infested, and the same is true of trees from Natal. Imported lemons from Southern Europe are seldom free of it, and fruit from the Canary and Madeira Islands is also infested.

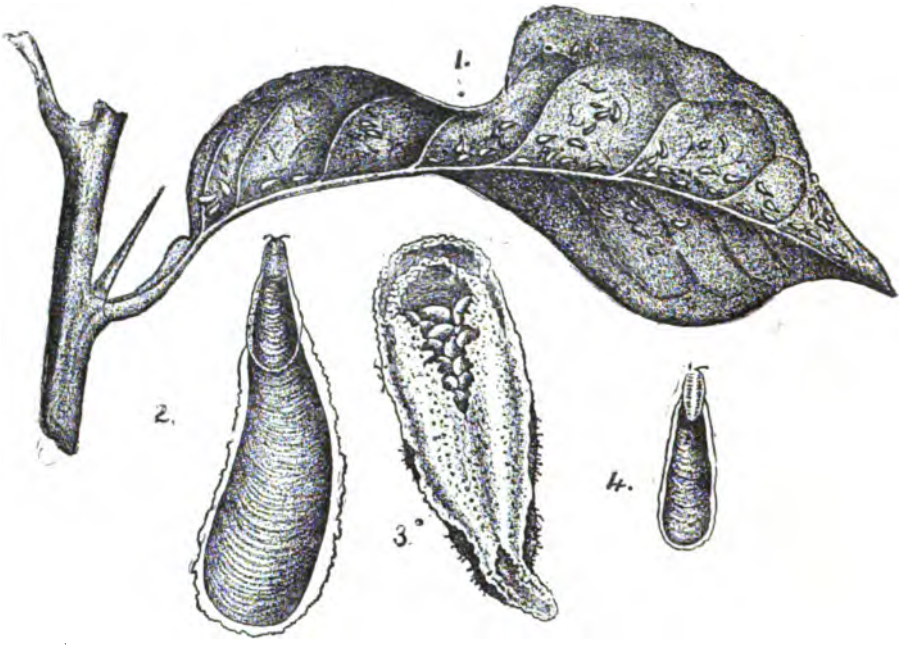


Fig. 12.—Purple Scale, *Mytilaspis citricola*, Pack. 1, scales on leaf of orange; 2, scale of female from above; 3, scale of female from below; 4, scale of male; 1, natural size; others much enlarged. (Copied from U.S.A. Dept. Agr.)

Occurrence in Cape Colony.—Two occurrences only of this scale are known to me, and at both of these places it is hoped that all the scales will shortly be destroyed. In one case the trees were imported from Natal seven or eight years ago; in the other the trees are supposed to have brought the scale from hot-houses in England. These two

known occurrences are near Cape Town, one in the Cape and the other in the Stellenbosch Division.

There is a possibility that the Purple Scale can never become a very serious pest in most parts of Cape Colony owing to the climatic conditions proving unfavourable. In Florida it is one of the two most injurious scales, but though often introduced into California on nursery stock it has not become a dread pest. This has been attributed to the drier atmosphere of the latter state proving fatal to the insect. Repeated assertions have been made that the scale has not been known to thrive anywhere in California, but the truth of these claims has been as repeatedly denied. Craw, the entomologist of the California State Board of Horticulture, in his report for 1893-94, states that he has seen trees in Los Angeles and San Diego Counties completely covered from the ground to the leaves and fruit with the scales. The weight of the evidence, however, leaves little doubt that a hot, dry atmosphere is unsuited to the insect. This susceptibility to climatic conditions may be the cause of the scale not having spread in the Stellenbosch orchard where it has been located, while it has spread and given every indication of vigour in the orchard found infested in the Cape Division; the rainfall in this second orchard is probably double what it is in the first. But even in the first orchard it has maintained itself for a number of years in spite of the frequent application of insecticides, and each season spreads out onto the fruit, never, however, menacing the life or health of the trees as does the Red Scale to surrounding trees.

But although we have a hot and dry climate the chances of the scale not becoming an obnoxious pest are too slight to justify risking its introduction by relinquishing the present restrictions on the importation of fruit or trees infested by it. While it might scarcely maintain itself on young trees, the favouring conditions of shade and comparative coolness would be obtained as the trees grew in size, and thus, ultimately, the scale might multiply and prove a serious pest.

Food Plants.—All kinds of citrus fruit trees are said to be attacked by the Purple Scale. Hubbard states that

although it is most at home upon the orange and its kind, it is not exclusively confined to plants of this family, but is probably a general feeder upon plants of the Order Rosaceæ, which includes nearly all of our fruit trees [" Insects Affecting the Orange," 1885, p. 27.]

In this colony, I do not know of its attacking other than citrus plants. Its occurrence on *Murraya*, a plant belonging to the same order as citrus fruits is recorded by Cockerell from Jamaica. [Insect Life, Vol. V., p. 160.]

Description.—The scales are about three times as long as wide, and are more or less mussel-shaped in outline, the anterior end being narrow and the posterior broad and round; that of the female is usually slightly curved and about one-eighth of an inch in length, while that of the male is nearly straight and not over half as long. The colour of the scale is variable but in old scales is generally purplish. The scales on imported fruit are generally brownish. The entire scale is easily removed from the surface upon which it rests, the thin, white under-scale remaining attached to the upper one and thus retaining the insect within; eggs, however, may be exposed near the broad end of the scale.

The eggs are white in colour and are not arranged in such regular order as those of the Long Scale. Hubbard states that the number varies from 25 to 70 and that the probable average is 45. Three or four broods are said to occur annually in Florida; the limits of the broods cannot be exactly defined but the number of migrating young reaches a maximum at least three times.

Remedies.—Insecticides for the Purple Scale should be applied when the number of young is at a maximum and the application should always be repeated after two or three weeks to destroy those which hatch subsequent to the first spraying. It is possible for all the scales on a tree to be destroyed by one treatment with hydrocyanic acid gas, but not very probable as any which happen to be in the egg state might escape.

If this scale is found in any orchard within the colony, every effort should be made to eradicate it before it can be

disseminated. It would be best to at once report the occurrence to the Department of Agriculture which might be able to arrange to have the trees fumigated. The trees now known to be infested will all be fumigated before this report is made public.

The Long Scale.

(*Mytilaspis gloverii*, Packard.)

Distribution.—The Long Scale is said to have been brought to Florida from China more than half a century ago. It is now recorded from the southern United States, Mexico, Ceylon, Europe, Queensland, and South Africa.

Occurrence in South Africa.—This scale has been found in four orange orchards in the Cape Division. It has not yet been observed in any other part of the colony, but the inspecting officer at East London has found it on oranges coming down the coast from Port St. Johns.

Food Plants.—The Long Scale is a pest upon all kinds of citrus trees; but I know of no published reference to its occurrence on plants of any other genus. Its ravages in Florida at one time threatened to put an end to orange-growing in that state; but now, thanks to the spread of parasites, the danger has passed.

Description and Habits.—The largest of the female scales measure about one-seventh of an inch in length, by about one-twenty-fourth in width. As a rule, the scales are quite straight with nearly parallel sides; but often, and especially if at all crowded, they are more or less curved. The male scales are seldom over one-twentieth of an inch in length. In colour, all of the scales are of some shade of brown; those covering living scales are brighter and lighter in colour than those covering dead insects. Many of the latter are usually found on infested trees, as the scales remain attached long after the death of the insects.

The colour of the female insects enclosed within the scales varies with age from white to purple. A similar

change in colour takes place in the eggs. When laid, they are white, but before hatching, they become purplish. They may be seen from beneath when the scale is raised. They are deposited in two straight rows.

Hubbard states that the female begins to oviposit in nine or ten weeks from her birth, and that the eggs begin to hatch within a week unless retarded by cold weather; and while the number laid varies greatly, it rarely exceeds thirty. Three or four generations are said to occur each year.

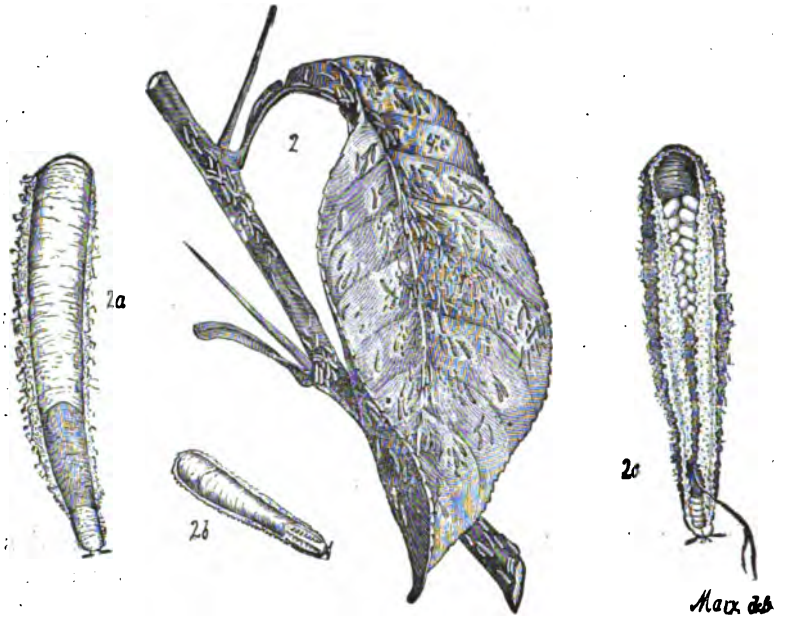


Fig. 13.—Long Scale, *Mytilaspis gloverii*, Pack. 2, scales on orange; 2*a*, scale of female from above; 2*b*, scale of male; 2*c*, scale of female from below; 2, natural size; others much enlarged. (From U.S.A. Dept. Agr.)

The Long Scale appears to thrive well where it has been found in the colony, and to injure the trees quite as much as does the Red Scale. It infests the bark, foliage, and the fruit. It seems to prefer the bark, and many trees have been noticed to be quite coated with it; but because of its neutral colour on the bark, it had before escaped attention.

Enemies.—In Florida, where this scale was very destructive during the middle of this century, it is now said to be fairly well kept in check by several species of internal parasites. None of these have been bred from scales found in this colony, but scales which appear to have been parasitized have been occasionally noticed. Among the lady-birds, those called the Shining Black and the Six Spotted with their larvæ (see page 56), are generally present on trees infested with this species, and with little doubt, they prey upon it.

Remedies.—The remarks about the application of insecticides for the destruction of the Purple Scale, apply to the Long Scale as well; and if this species is found elsewhere in the colony than in the Cape Division, the Department of Agriculture should be informed of the occurrence.

The Oyster-Shell Bark Louse.
(*Mytilaspis pomorum*, Bouché.)

Name.—The common name above given is the one by which the insect is called in nearly all American works. "Mussel Scale" is a more common name for it in England and Australia, but it is not adopted here, because it is liable to lead to the confusion of this insect with the Purple Scale of citrus trees, which is also known as "Mussel Scale". Tasmanian merchants speak of it as "Scale Blight", and "Common Apple-Scale" is the name by which it is familiarized in some publications.

Distribution.—This scale insect is probably the commonest and most widespread of all the scale insects affecting orchard trees. It is supposed to have been carried from Europe to the United States on nursery stock taken along by the early settlers; and it is said to now occur all over the United States where apples and pears are grown. It is unknown in few countries where apples are grown. It does not appear to be a common insect as yet in all of the Australian Colonies, but in one at least, Tasmania, it has

become firmly established. Most varieties of Tasmanian apples shipped to this colony are much infested; and Tasmanian consignors say it is almost impossible to get clean fruit.

Occurrence in Cape Colony.—No occurrences of this scale are now known in Cape Colony. Some infested trees were discovered in a town in the eastern part of the colony last year. These trees were burned. Investigation disclosed the fact that they had recently been imported from Holland, and were part of a large consignment. The Department of Agriculture had all of these trees traced, and, finding the insects on many, made arrangements for their destruction or proper cleansing.

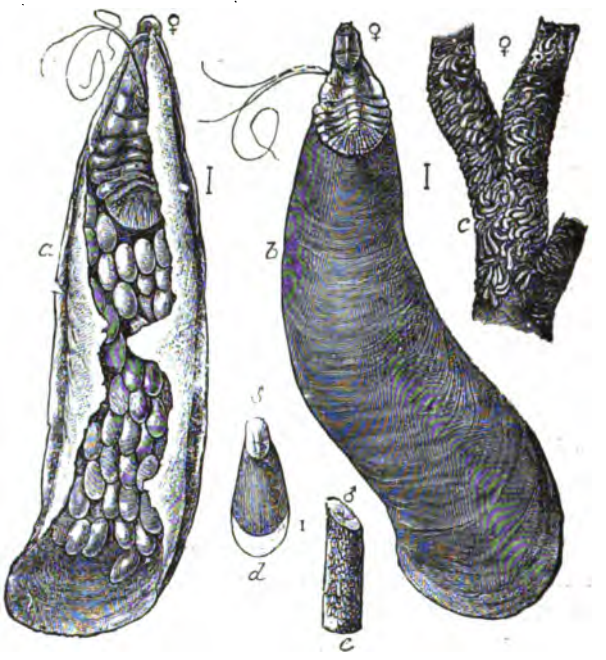


Fig. 14.—Oyster Shell Bark Louse, *Mytilaspis pomorum*, Bouché. *a*, scale of female from below; *b*, same from above; *c*, female scales on twig; *d*, male scale; *e*, male scales on twig; *a*, *b*, and *d*, much enlarged; *c* and *e*, natural size (From U.S.A. Dept. Agr.)

Food Plants.—Few scale insects are more general feeders. Among fruit trees, Apple, Pear, Quince, Plum, Peach, Apricot, Medlar and Fig, are all given as food plants; and among other plants, Willow, Poplar, Cottonwood, Hawthorn, Buckthorn, Wild Red Cherry, White and Black Ash, White and Red Birch, Elm, Linden, Horse Chestnut, Red and Striped Maple, Plane Tree, Lilac, Currant, Raspberry, Wild Grape, Honeysuckle, Spiræa, Dogwood, and Heath. Even still other plants are mentioned by some writers, but enough has been mentioned to impress anyone interested in the colonial fruit industry with the extreme objectionableness of this insect.

If infested apples were allowed to be landed in the colony, it is very reasonable to suppose that apple parings bearing scales would be thrown down on or near some food plant of the insect. Then when the eggs hatch, there would be nothing to prevent the young scales from spreading onto the plant. From this plant, others would gradually become infested, and in time the scale would gain a hold in our nurseries and orchards.

It does not necessarily follow that all of the given food plants suffer severely. Of the fruits, Apple suffers the most. Peach and Apricot are said to be infested in New Zealand and Tasmania, but are not mentioned among the food plants in the United States. Some of the other food plants mentioned suffer quite as severely as Apple; Lilacs are sometimes destroyed, and the young bark of Willow and allied trees is sometimes completely encrusted with scales.

Description.—In general appearance, this species bears a resemblance to the Purple Scale, but a comparison of the two will show slight differences in form and colour. Mature scales of the present species found on Tasmanian apples measure fully one-eighth of an inch in length by one-fourth as wide. They are distinctly brownish in colour, rounded behind, and of nearly uniform width except in the first third of the length which tapers nearly to a point. Normally, the scales are straight or nearly so, but often they are considerably curved. Specimens received from America on willow twigs are greyish.

The whitish eggs are deposited irregularly under the scale, and are nearly all exposed on raising the scale. According to Howard, the number varies between 42 and 86. The number under several scales on Tasmanian apples averaged between 70 and 75. In the northern United States, there is but one brood, while in the southern there are two. Thompson states that there is but one brood in Tasmania [Bulletin No. 1, Dept. Agr., Tasmania, 1892, p. 55], and that by the middle or end of February, the females are little more than bags of eggs. Eggs are present on apples received from that country in July. It seems odd that scales should be so common on the fruit when there is but one brood. In the northern United States, the eggs hatch quite simultaneously in the spring-time, and the young settle on the twigs before the fruit has fully formed; consequently, infested fruit is rarely seen. Thompson states that the eggs do not all hatch at one time in Tasmania, but that the young are constantly appearing throughout November and December.

In case the insect becomes established in this colony, there would probably be at least two broods; and not unlikely, insects in all stages would always be present on the trees owing to our winters and summers merging gradually into each other instead of abruptly as in more temperate climates. This prolongation of the hatching period would add greatly to the difficulty of combating the insect, for except when newly hatched, the insect is not easily destroyed by insecticides. Hence while in more temperate climates, one or two well timed sprayings might almost eradicate the insects, half a dozen might here be needed to effect the same results.

The White Peach-Scale.

(*Diaspis amygdali* Tryon.)

Name.—This is the insect referred to in the last annual report from this office as "Peach Diaspis"; but as "White Peach-Scale" is a more suggestive name to fruit growers to whom the generic name "Diaspis" gives no intimation that the insect is a scale, it is here adopted and will be

used in the future. In the United States, reference has been made to the insect under the names "New Peach Scale" and "West Indian Peach Diaspis". The specific name used in last year's report was *lanatus*, but the insects described under this name have since been proven to be identical with the species previously described under the name given in the heading.

Fig. 15.—White Peach-Scale, *Diaspis amygdali* Tryon. *a*, male and female scales on bark; *b*, female scale; *c*, male scale; *d*, group of male scales; *e*, natural size; others much enlarged. (From U.S.A. Dept. Agr.)

Distribution.—The original home of the insect is supposed to be somewhere in the West Indies. Elsewhere than on these islands, it has been found in Florida, Georgia, and the District of Columbia in the United States, in Japan, Australia, Fiji Islands, Ceylon and in this colony; but except in the West Indies, it is not recorded to be widely distributed.

Occurrence in Cape Colony.—There is no doubt that the White Peach Scale has been a denizen of this colony for at least fifteen years, and there is good reason for believing it to have been here for more than double that period. It is to be found in nearly every peach orchard in the Cape, Stellenbosch and Paarl Divisions, at many places in Worces-

ter, and to a slight extent in the eastern part of the colony at Port Elizabeth, Uitenhage and Graham's Town. In all likelihood, it occurs in many other sections since several nurseries are known to have disseminated it on nursery stock. It has been received from one farm near Barberton in the South African Republic.

Food Plants.—Peach and Mulberry seem to be the favourite food plants of this highly injurious insect. Apricot and Plum are often badly infested and sometimes even killed. Cherry is liable to be severely attacked; and though doubtless an exceptional food plant, Pear has been found slightly infested. *Myoporum insulare*, Yellow Jessamine (*Jasminum sp.*), Granadilla (*Passiflora edulis*), *Polygala myrtifolia*, Morning Glory (*Ipomœa sp.*), Fuchsia and Geraniums all may become very badly infested. Many other plants including the Cape Gooseberry and other Solanaceous plants are attacked to a less extent. In the West Indies, Grape, Capsicum and Cotton are included among the food plants.

Description and Habits.—The scale of the female is nearly circular, about one-twelfth of an inch in diameter, with an orange-yellow spot (the exuvia) midway between the centre of the scale and the front margin. Old scales and those fully exposed are sometimes quite grey, but on the fruit and when sheltered by the buds, the colour is almost white. The situation makes some difference in the rotundity of the scale and in its form, those on nearly level surfaces being much flatter and more nearly round than those on the young wood. The male scale is about one-sixteenth of an inch in length and about one-third as wide. It is snow-white in colour, and the yellow exuvia is situated at the anterior extremity; the sides of the scale are slightly convergent in the same direction. A slight ridge extends along the middle of the scale. Male scales are often densely massed on the branches which then have the appearance at a short distance of having been newly whitewashed.

The female scales remain attached to the tree long after the death of the occupants, and hence the bark of

badly infested trees may be coated with the dirt-begrimed remains of several generations.

The insects are exposed when the scales are raised ; they are more or less pink in colour. The adult males are red with transparent wings. About 150 eggs are deposited by a single female. These, as a rule, are of much the same colour as the body of the female, but sometimes are much lighter. The young, also, are somewhat variable in colour though usually distinctly pink and so much so as to be quite conspicuous against the bark when numbers appear at one time. Soon they become covered with a coat of loose, white, waxen threads which give them a " woolly " appearance that is very noticeable.

Howard states that there are three annual generations at Washington, D.C., and that the development is compara-

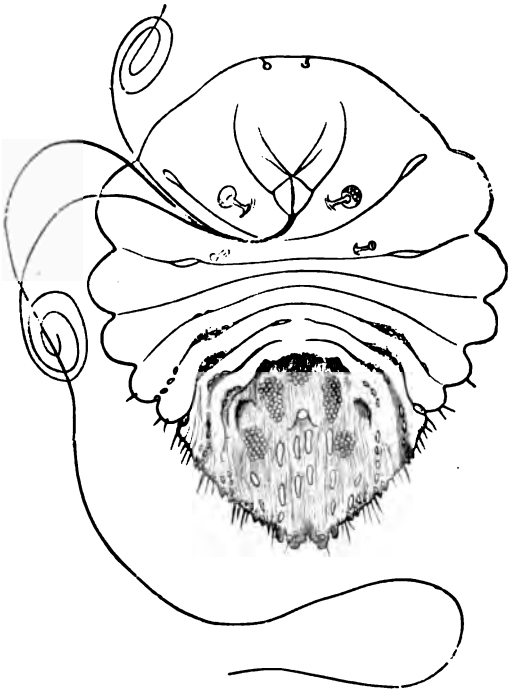


Fig. 16.—White Peach-Scale, *Diaspis amygdali* Tryon. Adult female removed from scale, greatly enlarged. (From U.S.A. Dept. Agr.)

tively regular. His observations do not hold true for this colony. There were four generations during the past year at Mowbray in the Cape Division, and great irregularity in the appearance of these broods on different trees. There was no period of complete dormancy, although the development appeared somewhat retarded during the winter. The peach orchard at Fernwood, Newlands, furnished a good illustration of how irregularly the insect may develop under our condition of mild winters. Young began to appear on the trees at one end of the orchard before the middle of April while at the other end, some eggs remained still unhatched at the first of June. There are eleven trees in each row. The trees on which the young appeared earliest remain in the sun-light for a longer period during the afternoon than those on which the young appeared later and to this fact the difference in the time of appearance is attributed.

When young trees are infested by the White Peach-Scale, the stem of the tree is often the only part infested, but as the trees grow older, the infestation extends out on to the branches and twigs. The foliage is seldom attacked, and never, as far as I have observed, to more than a slight extent.* The fruit of the Peach is quite subject to attack and is sometimes badly malformed and disfigured owing to the injuries received. As a general rule, a reddish discolouration forms about the scales on the fruit and extends into the tissues beneath.

Enemies.—Four species of lady-birds have been observed to feed upon this scale in the western part of the colony. The most important of these is one which we will call the Two Spotted Lady-bird. Technically, it is known as *Chilocorus distigma* Klug. It is a large lady-bird, measuring from one-fifth to one-quarter of an inch in length. The wing covers are black and are ornamented with two prominent red spots, one in the centre of each. The larva is a very spiny black and white creature and is more efficacious in the work of destroying the scale insects than the adult beetle. I have not observed this lady-bird

* Since above was written, mulberry trees, the foliage of which was very much infested, have been observed.

to prey upon any other of our scale insects but it probably attacks others. Few farmers are acquainted with it, and I am inclined to believe from its sporadic occurrence that it has some formidable enemy. Sometimes a few trees in an orchard will swarm with hundreds of them while none at all are to be found on other trees a few rods away that are just as badly infested by the scale. The Shining Black Lady-bird and the Six Spotted one are generally present with their larvæ on infested trees. Also the adult of the Yellow Lady-bird, and the larva of a species of Aphis-lion.

Wherever I have found this scale insect in the Western Province, it has always been more or less infested by a minute Chalcid fly which appears to be identical with *Aspidiotophagus citrinus*, Craw. At some places visited last year, almost every scale on badly infested trees bore the exit mark of this tiny parasite; but the scale insects appear as abundant this season as they did during the last even in the orchards where the parasites were most plentiful.

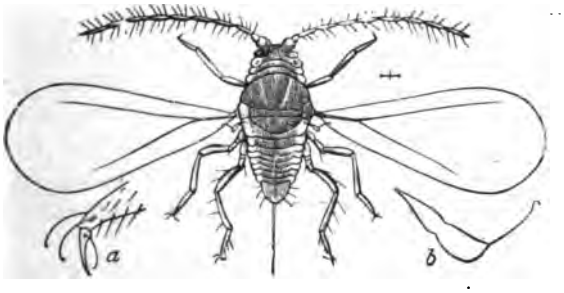


Fig. 17.—White Peach-Scale, *Diaspis amygdali* Tryon. Adult male, greatly enlarged. (From U.S.A. Dept. Agr.)

Remedies.—This appears to be an unusually difficult pest to destroy; and the chances of exterminating it without sacrificing the infested trees after it once becomes thoroughly established in an orchard are small. As with all other scale insects, its most vulnerable period is immediately after the eggs are hatched. For several days at this time, the larvæ are not protected by a scale and will succumb to resin wash, paraffine emulsion, and to hot water containing a pound of soap to three gallons. Unfortunately,

the development of the insect is irregular in this climate and no date can be given at which all of the insects will be "ripe" for spraying. But this period is so much more favourable for destroying them than any other that I am sure that it will be well worth the while to watch the development of the insects, and delay spraying until they are hatching. If no eggs are present beneath the scales, the young will not appear for some time; but if eggs are found, the trees should be subsequently examined at least once a week. Two or more sprayings at intervals of ten days or a fortnight should be given. There will be no difficulty in seeing the young. They generally appear once or twice during the winter when the leaves are off.

Some parties who have sprayed without observing what stage of life the insects were in have reported excellent results; while others, using the same insecticides, have met with almost total failure. My own experience and observation lead me to believe that the first parties were fortunate in catching the insects before they had secreted the scales; while the latter chanced to spray when the insects were protected.

Either resin wash or lime-sulphur-salt mixture had best be used if the spraying is done when the leaves are off. Both of these washes adhere to the trees for some time, and apparently act upon many insects that are hatched subsequent to the spraying. If the spraying is done during the summer, either resin wash or paraffine emulsion may be used; the former diluted half as much again as the normal wash, and the latter used with twelve to fifteen parts of water to one of emulsion.

The lime-sulphur-salt wash will seriously injure the trees if applied after the buds have opened; but in only one case have I heard of injury to the unopened buds attributed to its use. Then the wash was applied very hot, and just as the buds were breaking. No injury was done to the leaf buds, but a large percentage of the fruit buds failed to develop. The owner of the orchard believes the damage to have been caused by the heat of the wash.

The resin wash at normal strength does not appear to injure the buds unless it is applied as they are opening; then, some of

the petals are crippled, perhaps owing to the sticky nature of the wash. There was no diminution from the average bearing of fruit in the case of two peach trees sprayed when the blossoms were open, but spraying at this time is not recommended. The application of resin wash, made one-half stronger than the normal wash, to peach trees in Florida, resulted in the destruction of most of the fruit buds when used later than the first week in November. [Bulletin 29, Florida Agr. Exp. Sta.] In this hemisphere, the corresponding period would be the first week in May; and when this strength of wash is used here, it had best, therefore, be applied previous to this time. However, no injury resulted to some nectarine trees from spraying with the stronger wash as late as May 22nd.

Fumigation with hydrocyanic acid gas has been found effectual in destroying the insects when the same amounts of the chemicals are used as for fumigating citrus trees; the eggs, however, nearly all hatched.

The Brown or Soft Scale.

(*Lecanium hesperidum*, Linn.)

Names.—Probably no other scale insect has received so many common names as this one; those here adopted are the most common in use, and when used together are more suggestive of the insect than any one or two of the other names. Among these are "Turtle-back Scale," "Broad Scale," "Flat Scale," "Black Scale," and "Holly and Ivy Scale." In the Midland Districts of this colony, many of the farmers know it under the name "Mussel Scale."

Distribution.—This insect was described in Europe more than a century and a half ago. It now occurs in all parts of the world, or at least, it has been reported from all of the continents.

Occurrence in Cape Colony.—Probably no district of the colony is entirely free of this scale; I have found it in all of the dozen or more districts that I have visited. But though widely distributed in the colony, there are many farms which to all appearances are yet entirely free of it.

Food Plants.—The wide distribution of this species is largely due to its ability to thrive upon a large number of very common ornamental plants. In temperate climates, it is a well known greenhouse pest. In warmer countries, it thrives out of doors, and among fruit growers is chiefly noted for its attacks to citrus trees; while gardeners find cause to complain of its injuries to a wide variety of plants. During the past year, I have noticed it in greatest abundance on Abutilon, Camellia, Bay, Pepper Tree, Rose, Blackwood, Holly, Quince, Guava, and Fig, in addition to citrus fruits.

The scales infest the foliage and the green bark; they rarely spread onto the fruit, and are seldom found on the old wood. Therefore, the injury done to young trees is relatively greater than that done to old stock. Few plants except tender annuals ever succomb to their attack, but the growth may be greatly retarded.

Description and Habits.—The male of this species has been observed by few students. One writer states that it is excessively small, without eyes or wings, and that it is retained within the body of the female [see "Insect Life," Vol. II., p. 370]; another—Matthew Cooke—states that he once saw an excessively minute winged insect, which he could only imagine to be the male of this species, issue from beneath a female which he had imprisoned for examination. The females, then, are the only scales which concern practical fruit growers. When full-grown these are about one-seventh of an inch in length and one-eleventh in width. Unlike the scale insects which have previously been considered, this one secretes no true scale covering; the apparent scale being the dilated dorsal surface of the body. The colour varies with age from yellow in the young insects to what is best described as brown in the adults. The appendages are conspicuous in the young, but do not develop in proportion to the body, and finally become almost useless.

Eggs have never been observed, and the young appear to pass alive from the body of the mother. As they emerge, the underside of the mother's body gradually

becomes concave and forms a shelter for them. Twenty to thirty or more young may often be counted beneath a mature female.

Fig. 18.—Brown or Soft Scale, *Lecanium hesperidum*, Linn. Adult females on Orange, natural size. (From U.S.A. Dept. Agr.)

The Brown Scale is more easily detected than any other of our common scale insects by reason of the abundance of honey-dew which it secretes and the consequent growth of the smut-like fungus. The honey-dew attracts troops of ants, and the presence of these insects, in numbers on the trees, is almost a sure indication of the presence of this scale or of aphides. Many other scale insects exude honey-dew in the same manner, and thus also attract ants, but the Brown Scale is the only common one on fruit trees in the colony, with the exception of the Australian Bug. An infested leaf, somewhat coated with the fungous growth, is illustrated on the coloured plate.

The numbers of the Brown Scale fluctuate with the season to a much greater extent than the numbers of most scale insects, especially those already considered in this report. Few living scales are found during the winter, and the increase, with returning favourable conditions, is very rapid. As the smut-like fungus remains on the trees through the interval, the diminution in numbers escapes general observation. The fluctuation is due, not alone to climatic conditions, but, apparently, to the hardening of the bark and foliage as well.

Enemies.—Were it not for its host of natural enemies, the Brown Scale would prove a serious pest; and it is probably owing to the local scarcity of enemies that it is so injurious on some isolated farms. In the western parts of the colony, at least, parasites and predaceous insects which attack it are plentiful. If a number of the scales are examined, some will be seen to have a minute hole at the top; these holes are openings through which parasites have escaped after having developed in the body of the scale insect. Two species of these internal parasites have been reared from scales found at Constantia. As a rule the parasitized scales are not full grown, and one if not both of the parasites reared causes its host to swell and turn black, leaving only a narrow margin of the former colour of the scale. These blackened scales are often mistaken by farmers for insects of a distinct species.

Another insect which appears to do considerable execution among scales of this species is the caterpillar of a small moth, the name of which I have not ascertained. This has been observed at Cape Town, Paarl, Wellington, and Graaff-Reinet. At the latter place it was noticed on a number of Blackwoods, and thousands of its cocoons occupied the crevices in the trunks of the trees. The caterpillars live within closely woven silk cases which resemble the scales in form and colour. These cases are enlarged as the insect grows and serve as a shelter during the pupal stage. The Shining Black Lady-bird is the only native species of lady-bird which I have observed feeding on this scale.

Remedies.—The Brown Scale yields much more readily to insecticides than the Red Scale or other of the armoured scales. And, moreover, the scales are more easily reached by the spray, as they are almost wholly confined to the foliage and young growth of wood. Hydrocyanic acid gas has proved a complete success; all the scales on infested trees have been destroyed without injuring the pupæ of the predaceous lepidopteron alluded to above. A number of pupæ have been collected from trees which had been fumigated, and in due time moths emerged from all. Resin wash has destroyed all of the scales on small trees when used at a strength that failed to destroy over fifty per cent. of the Red Scale on trees sprayed at the same time. Even common laundry soap, when used at the rate of one pound to two and one-half gallons of water, is very effectual.

Although the scales are easily destroyed, it is no easy matter to kill all that are on a large tree by the use of insecticidal washes. Some almost invariably escape the wetting and renew the infestation. This is apt to be the case even when extreme care is taken to have the spraying thoroughly done; protection being afforded to the escaping scales by a contortion of the twig, by a dried leaf sheltering them, or by some similar means.

The Black Scale.

(*Lecanium oleæ*, Bern.)

Name.—The specific name of this species is derived from the generic name of the Olive, which tree is said to be the principal food plant of the insect in Europe. The popular name "Black Scale" is suggested by the colour of the mature scales, which, though not black, are often very dark. This name has come into common use in the United States and in Australia. In this colony there is a species of *Lecanium* on the Kei Apple (*Aberia caffra*) which is more deserving of the name "Black Scale", but, as it does not appear to be common or to occur on orchard trees, there is no need to re-name the present species. The one on Kei Apple is so little like the "Black Scale" in general appear-

ance, that there is no likelihood of the two becoming confused.

Distribution.—The Black Scale has been found in the south of Europe, and in various parts of Australia, New Zealand, North America, and South Africa. Plants arriving at San Francisco from Japan, and at Cape Town from Brazil have been found infested by it, so it must occur to some extent in these countries. It has also been seen at the Cape Town Docks on trees arriving from Australia and from Natal. Its occurrence in the latter country has been verified by A. W. Cooper.

Occurrence and Food Plants in Cape Colony.—It has been found in Cape Town and in several other parts of the Cape District, at Ceres, and at Port Elizabeth. At none of these places is it causing much trouble, and complaint of it has been made at one place only. About Cape Town it occurs on White Jessamine, Granadilla, Cape Gooseberry, and Oleander; at Ceres, on Quince and Oleander; and at Port Elizabeth, on Oleander and two plants which were not recognised. At every place, Oleander seems to be the normal food plant. Only once have I seen it on citrus trees; in this case, it was on trees which had recently been imported from Australia, and steps were at once taken to exterminate it.

It has been observed that this scale is far more destructive near the coast in California than in the drier inland districts, and that immense numbers of the young perish with the extreme heat of mid-summer. Therefore, it is to be expected that if the insect ever becomes destructive in this colony, it will be in the coast districts. It cannot now be said to be a common species where it does occur in the colony, but its scarcity appears to be due to the abundance of parasites rather than to unfavourable climatic conditions.

Food Plants Abroad.—The Olive is said to be the principal food plant in Europe; and from it the scales are said to spread to other plants. In California, Coquillett states that citrus trees, Olive, and Apricot are very subject to attack, but that the scales are able to sustain

themselves on a great variety of plants; in proof of which he cites nearly three dozen plants on which he has found full-grown specimens. Comstock mentions at least a dozen other plants among those upon which he has found it in California. Maskell mentions that various native trees are attacked in New Zealand in addition to Camellia and other plants. Among the plants other than those already specified which are mentioned by Comstock and Coquillett are Almond, Guava, Plum, Pear, Apple, and Rose.

Fig. 19.—Black Scale, *Lecanium oleæ*, Bern. Adult females on Olive, natural size; *a*, adult female, enlarged. (From U.S.A. Dept. Agr.)

Orange and other citrus trees in some parts of California suffer severely from this pest, which on these trees is dreaded almost as much as the Red Scale. Apricot and Olive culture in the coast counties of the same state is said by Craw to have been severely injured by it; and the same writer states that the insect was known at Nice (France) and did considerable damage to Olive in that locality as far back as 1743.

As the type of the insect found in the colony is unknown on any of the fruit food plants to which the insect is so destructive in other countries, as much care should be exercised to prevent the introduction of this species from abroad as would be taken to prevent the introduction of a destructive insect altogether new to the country.

Description and Habits.—Like other Lecaninæ, the Black Scale does not possess a true scale which can be separated from the body; but the dorsal skin hardens with age and finally becomes quite firm, and as this dorsal skin then resembles a scale, it is spoken of as one. The full-grown insects are dark reddish-brown in colour. The shape and size differ on different parts of the same food plant. On the foliage and twigs, the insects are nearly hemispherical in form, though, as a rule, slightly longer than wide; the average length is about one-sixth of an inch. The upper surface bears a more or less prominent ridge; this is crossed at right angles by two ridges which are about as far distant from each other as each is from the end nearest to it. The longtitudinal ridge is most pronounced between the transverse ridges so that a capital H is thus formed in the middle of the back by the three ridges.

When the scales occur on the branches and large limbs, the hemisperical form is lost, the insects being little raised above the bark; the circular outline is retained, but with less tendency toward elongation, some scales measuring even slightly more in width than in length. What is lost in height is recovered in increased length and breadth, and specimens measuring up to one-third of an inch are not uncommon on the bark. The markings decrease in distinctness with the flattening of the surface and become difficult to trace. The surface of the scale is not smooth, but is covered with fine depressions; under some circumstances, these depressions become filled with a white, finely powdered substance. The scales seen on imported plants have without exception been a trifle lighter in colour than those found on trees grown in the colony; these are often so dark as to appear blackish unless closely examined.

The difference in the form of the scales in different situations on the one plant is interesting. It seems

probable that the natural tendency is toward the flattened form; naturally a more rounded form is assumed on the twigs because of the rotundity of their surface. This explanation for a rounded form will not apply to the foliage, for here the surface is flat; but can it not be that the constant motion of the foliage caused by the wind checks the tendency toward increased diameter and thus exacts an upward growth?

Californian observations indicate that there is but one annual generation of the Black Scale, and that the development is very slow. The eggs are found in greatest abundance during the first months of summer. They are laid beneath the body, which gradually shrivels until it becomes hardly recognizable. The dorsal skin, however, remains intact and shelters the eggs. The number of these is enormous. Coquillett records finding above 2,200 beneath one scale.

Copious quantities of honey-dew are exuded by the insects. This has the usual effect of attracting ants to the trees and of supporting a growth of the smut-like fungus. The fruit of badly infested citrus trees in California gets much covered with the fungus.

Enemies.—Internal parasites seem to be quite able to take care of this scale where it now occurs in the colony; but it is unwise to assume that this would continue to be the case were the scale to become established in large citrus orchards. No studies have been made on the parasites which perform this valuable service, and I cannot say whether or not they are all of one species. About Cape Town, at least, an undescribed species of *Aphycus* keeps the scale in check. Five of these tiny, four-winged flies have been reared from a single scale, and so common are they that hundreds of scales may be examined before finding one which has not been attacked. When fully developed, the parasites escape through small, round holes which they cut through the scale. If scales thus perforated are removed and examined, they will be seen to contain a mass of chaff-like egg-shells, among which, perhaps, are a few live eggs overlooked by the parasites.

Other enemies probably prey upon the Black Scale in

the colony, but I have not had the opportunity of seeing any at work. Various lady-birds have been observed to feed upon it in other countries, and also species of lepidopterous larvæ, which in more popular phraseology are caterpillars; also several internal parasites allied to the one found in this colony. But, notwithstanding these enemies, the scale is a serious pest in California and elsewhere.

Remedies.—Fumigation with hydrocyanic acid gas at a time when no eggs are beneath the scales has become a favourite remedy in California. It is thoroughly efficacious against the scales, but at the strength used, it appears to have little effect upon the eggs. Resin wash is said to destroy most of the eggs and the young insects, while many of the adults escape. It is, then, an effectual remedy if applied about the time of the hatching of the eggs; several applications are required to keep the scale well in check.

The application of any remedy is not now often needed in this colony. The only cases which have come to my notice where it was desirable to apply remedies were Oleanders in private gardens; these had become more of an eye-sore than an ornament from the smut-like fungus which accompanies the scales.

Australian Bug.

(*Icerya purchasi* Maskell.)

Names.—Australians may not relish the appellation here adopted for this pernicious pest, but it is a name so deep-rooted at the Cape that it will probably always remain the most familiar of the several names by which the insect is called. "Dorthesia" seems to be the next common name, but since it has no significance with reference to the insect and perpetuates an error in the classification of the insect, it being the old name of another genus of insects (now Orthezia), its use should not be encouraged. In American and Australian literature, the insect is generally referred to as the "Cottony Cushion Scale." "White Scale" and "Fluted Scale" are other names used to some extent; the

latter name is a very applicable one, but is seldom heard in Cape Colony.

Distribution.—Australia is generally conceded to be the native home of the insect. From there, several other countries have imported it, either directly or indirectly. It is now known to occur in Tasmania, New Zealand, Sandwich Islands, St. Helena, Mauritius, California, and South Africa. In all the countries where it is known, even in Australia, it has been a dreaded pest.

Occurrence in Cape Colony.—The insect was reported in South Africa by Roland Trimen, then Curator of the South African Museum, in 1877; it has been known by him since 1873, and was first observed in the Botanic Gardens at Cape Town. Gradually it extended its range to nearly all parts of the colony and neighbouring states, everywhere proving destructive, especially to all kinds of citrus trees. As in other countries, all sorts of remedial measures were adopted, but none proved of much value. The cultivation of citrus fruits and of some of the other favourite food plants of the insect was rapidly becoming impossible in the country, when natural checks appeared and stayed the invasion in a manner unparalleled in the annals of Entomology. These natural checks, which are predaceous lady-birds, are now prevalent in almost every locality frequented by the scale, and suffice to keep it reduced to small numbers. There still remain many isolated farms in different parts of the colony not yet reached by the scale, and, consequently, neither by the enemies of the scale; these places have most to fear from an outbreak.

Food Plants.—The Australian Bug is so nearly omnivorous that there is no need to enumerate the plants upon which it has been found. Acacias are preferred, particularly the Blackwood (*Acacia melanoxylon*); then, apparently, the various citrus fruits. About Cape Town the insect may at any time be found in at least small numbers on Plumbago.

Description and Habits.—Probably few other insects are

so well known to our farmers as this one, but occasionally farmers are met who have never seen the insect and would not recognise it if they did see it; so no apology is needed for the short description here given.

The adult female is the most conspicuous form. The entire length of the body and ovisac is generally between one-fifth and one-third of an inch, but specimens measuring up to one-half of an inch are sometimes found. The body is reddish and more or less covered with a yellow, meal-like secretion, and white threads of wax. The ovisac projects behind the body, which it often exceeds in length when fully developed; it is white in colour, and is corrugated or "fluted" in the direction of the body. On breaking through the covering, the sac is seen to be filled with oval, red eggs, embedded in a mass of fine wax threads resembling cotton in appearance.

The adult male is not very common, but may sometimes be found where the insects are abundant. Its body is red and measures about one-eighth of an inch in length. The wings are smoky-brown and longer than the body, expanding to a width of slightly more than one-fourth of an inch. The antennæ are long, slender, nodular, and hairy.

The number of eggs laid is variable. Several ovisacs examined during the past year contained between 400 and 600. Riley records a case in which the number of eggs in the ovisac and body together with those that had hatched at the time of counting was 1,135. The larvæ hatching from the eggs are tiny, red specks, about one-twenty-fifth of an inch in length.

The development of the insects varies greatly with the food plant and with the season. All stages are usually to be found together. According to Riley, there are probably three annual generations in California.

The Australian Bug differs from most other scale insects in being active during the greater part of its life. The newly-hatched larvæ are very active, and, as a rule, seek the twigs and foliage. As the adult stage approaches, both sexes generally migrate to the larger branches. The male then remains stationary until it becomes winged; but the female may still slowly crawl to new situations. This

ability of the insect to move about greatly increases the chances of its spreading to other trees or plants through the agency of the wind, running water, and by flying insects frequenting infested trees as well as birds.

Fig. 20.—Australian Bug, *Icerya purchasi* Mask. Adult females on twig, natural size. (From Miss Ormerod's "South African Insects.")

In common with most aphides and many scale insects, the Australian Bug exudes "honey-dew." Part of this is carried off by ants which are always in attendance on the insects to obtain this substance; and the rest, falling on the surfaces beneath, furnishes breeding grounds for the black, smut-like fungus which is an invariable accompaniment of insects excreting honey-dew.

Enemies.—It has been stated that this insect proved very destructive in the countries into which it was introduced. The reasons for its destructiveness are simple. Its remarkable fecundity, and its ability to thrive upon a great number of plants, caused it to multiply quickly; its large size, coupled with the fact that at no time is it immovably attached to its food plant, favoured its spread by strong winds and by other outside agencies; but these factors in its multiplication and spread all hinged upon one other condition, the immunity of the insect from natural enemies. Nature had provided the insect with powers to ensure the perpetuation of the species despite of many enemies, and when relieved of these enemies by being transported to countries where they did not exist, the insect naturally multiplied at a prodigious rate, with consequent great destructiveness. This condition of things remained until natural checks were restored. In California, this was done by importing *Vedalia cardinalis* from Australia. In this

colony, the credit for restoring the natural balance is divided between Vedalia obtained from California, through the courtesy of the United States Government, and another lady-bird, *Rodolia iceryæ*, which appeared upon the scene from no one knows where. Both lady-birds were widely distributed throughout the country at about the same time, and so it happens that many claim that the Rodolia did the great work, while an equal number attribute it all to the Vedalia. Suffice it is, however, that between the two the Australian Bug was reduced to inconsiderable numbers within a very short time.

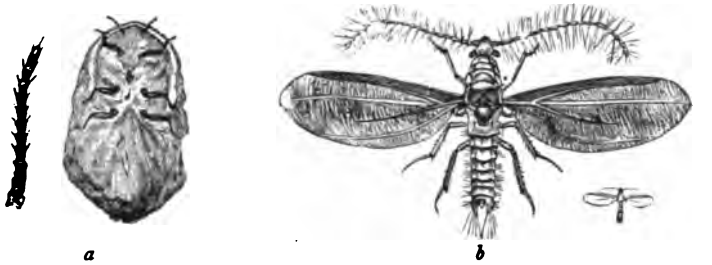
Their method of attack explains the speedy work of subjugation. The eggs are generally laid beneath or near the ovisac of the Australian Bug, and the larvæ on hatching burrow into the ovisac and attack the eggs; thus in a few meals is devoured what in a short time would have been a myriad of young scale insects. The time occupied by a generation of the Rodolia is unknown to me. Coquillett found that in the case of Vedalia, but thirty-five days was necessary from egg to beetle, and that the females at once began to lay, probably averaging from 150 to 200 eggs. After devouring the eggs, the scales themselves are eaten. Thus attacked in the egg state by voracious insects rivalling themselves in the capacity to multiply, the Australian Bug has lost its destructiveness, seldom increasing sufficiently to do damage or even to attract attention where it once was so abundant.

On isolated farms, and perhaps even in small towns where there is little for the scale to infest, it may occasionally happen that both the scale and its lady-bird enemy become extinct, the former from the attacks of the latter, which in turn dies for want of food. In such a case the scale may spread and cause much damage if again introduced; but, fortunately, the lady-bird seldom exterminates the scale, simply keeping it reduced to uninjurious numbers. These numbers, of course, are subject to considerable variation. Sometimes a plant or two may become considerably infested before the lady-bird puts in its appearance, but given a little time it will almost invariably come. Therefore the appearance of the scales on a few plants is no cause for anxiety, except on isolated farms or

in small towns where it has hitherto never been known or has been entirely absent for a long period.

The Vedalia is not known to attack any other scale insect than the Australian Bug in South Africa; and it is undoubtedly this lady-bird, not the Rodolia, that now holds the scale in check in most parts of the colony. During the past eighteen months, I received the Rodolia but once in sendings of the scale, while the Vedalia was received a great number of times, and from the Free State and Transvaal as well as from many parts of this colony. It should be mentioned, however, that many persons confuse the Rodolia with the Shining Black Lady-bird, a common insect in various parts of the country, and which not infrequently is to be found abundant among the scale insects.

At least two other species of lady-birds attack the Australian Bug. One of these was mentioned in my last report as *Scymnus sp.*, but proves to be a species of *Rhizobius.** The other is the Six Spotted Lady-bird (*Pharus sexguttatus*). The number destroyed by these lady-birds is insignificant to that destroyed by the Vedalia, but at times the *Rhizobius* is quite common in the suburbs of Cape Town.



a *b*

Fig. 21.—Australian Bug, *Icerya purchasi* Mask. *a*, adult female from beneath, enlarged; antenna, much enlarged; *b*, adult male, much enlarged; the natural size is shown in small figure to the right. (From Miss Ormerod's "South African Insects."

Another enemy to the Australian Bug is a species of Aphis Lion; but I have nowhere observed this insect to occur in numbers sufficient to materially affect the increase of the scale insects.

Remedies.—When the Australian Bug anywhere in this

* Determined by E. A. Schwarz.

colony increases to an alarming degree, a few specimens of either Vedalia or Rodolia should be procured and liberated on one of the infested trees. The procurement of the lady-birds may be attended with some difficulty. As has been explained above they are constantly present about the large towns, but so well do they keep their prey in subjection, that they are never long to be found at any one place, and several hours or even days may be spent in searching for them before the requisite number is obtained. Until recently the Department of Agriculture continued to supply applicants free of charge, but it has become almost impossible to do this, because of the number of applications. Now a charge of ten shillings is made for each "colony" sent out. The charge is made, not to offset the expense of finding the insects, but to discourage needless applications, it having been proved that the Vedalia was already present at the majority of the places from which the applications were made, and, consequently, that parties really requiring the insects had to wait while these needless applications were being filled.*

To hold the insects in check while awaiting the lady-birds, thorough application of Resin Wash are of great value. On several occasions during the past year when lady-birds could not be immediately procured, the applicants were advised to spray with this compound, and excellent results were subsequently reported.

Mealy Bugs.

(*Dactylopius* spp.)

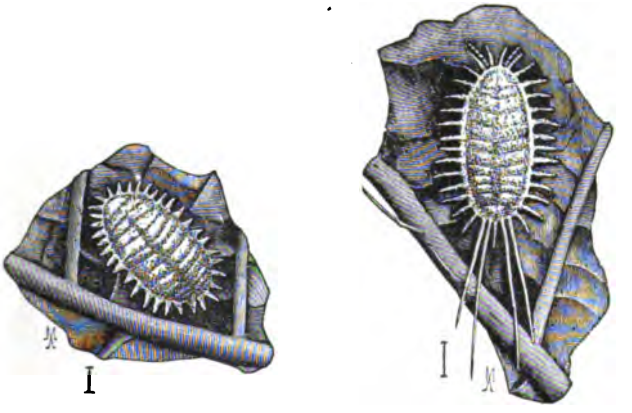
Name.—Two or more species of Mealy Bugs are found in the colony, but as the specific identity of these has not been established, they will be considered together under the common name given by gardeners to scale insects of this kind. The name is descriptive of their appearance, the common species of this genus being covered with a meal-like powder.

How Disseminated.—Some species of Mealy Bugs have become almost cosmopolitan pests by accompanying nursery stock. One species, presumably *Dactylopius citri*, is not

* See Agricultural Journal, October 15, 1896, p. 545.

infrequently found on young trees brought to Cape Town from abroad, and a few are generally present in all packages of imported oranges and lemons. Those found on the fruit are generally adult females, and almost invariably they are snugly ensconced in the depression at one end or the other of the fruit.

Injuries Abroad.—Mealy Bugs are notorious pests in greenhouses in temperate climates, and in some semi-tropical countries are destructive pests out-of-doors. A common species (*Dactylopius citri*) has been one of the worst enemies to the Orange in Italy, * and the same one has been quite destructive in orange groves in some parts of Florida.



a *b*

Fig. 22.—Mealy Bugs. *a*, *Dactylopius citri*; *b*, *Dactylopius longispinus*: the natural length of the insects is shown by the short lines below the figures. (From U.S.A. Dept. Agr.)

Food Plants.—A wide variety of plants are attacked by the most common species of the Mealy Bugs at the Cape. § Citrus trees and Guavas suffer more severely than other fruit trees, but it has been only occasionally that badly infested trees have been observed, and then not more than a few at a time. Next to these trees, the Fig seems most subject to attack among the fruits. Among ornamental plants, the chief sufferer is the Granadilla (*Passiflora edulis*). It is a significant fact that this plant always

* *Insect Life*, Vol. I., p. 118. § Probably the *Dactylopius citri* mentioned above.

suffers most when grown under the projecting eaves of a roof; the insects on such vines are protected from rain.

Description and Habits.—The females of the common species are oval in outline, and when full-grown are about one-sixth of an inch in length. They are dull brownish-yellow in colour and covered with a thin coating of white meal-like powder; this powder also coats a number of short appendages which project from the body all around. The males are very tiny creatures, and like other coccids, are provided with a pair of wings. Two very slim appendages which are quite as long as the rest of the body project from near the end of the abdomen; these are covered with whitish wax.

The eggs of some Mealy Bugs hatch almost as soon as they leave the body, but our common species lays its eggs in a fluffy mass of cotton-like threads at the extremity of her abdomen, and often clusters of eggs are found without an accompanying insect. The eggs in one of these masses number several hundred, the average in four counted being about 350.

Mealy Bugs avoid exposed positions on plants, seeking by preference the protection afforded by the forks of the stem, or by leaves which have become curled; the somewhat elevated ribs of the leaves of Guava extends a welcome shelter, and the intertwining runners of the Granadilla afford choice nooks. The fruit is also an attraction. Oranges which hang after they have ripened are almost sure to become infested if any of the insects are on the tree; the portion of the rind immediately about the stem and the depression at the opposite end are generally the only parts effected.

The Mealy Bugs exude more or less honey-dew, and hence, when they are common on a tree, they are accompanied by the smut-like fungus.

Enemies.—For some reason or other, Mealy Bugs do not appear to be much of a pest with us. If this is due to the presence of natural enemies, these have escaped my notice; but I am inclined to believe that the climate is accountable for their fortunate unimportance. However, it may be that in some sections of the colony and even in all sections

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in some years, they are abundant and comparatively injurious; I am speaking from less than two years' experience in the colony.

Both the adults and larvæ of the Six Spotted and the Shining Black Lady-birds have been found to destroy Mealy Bugs, and these beetles are generally common on badly infested trees. A small bird, probably *Zosterops capensis*, or a closely allied species, is said to feed on the Mealy Bug on Guava in the eastern part of the colony.*

Remedies.—Owing to the habit of the Mealy Bugs to partially or wholly secrete themselves, it is a difficult matter to reach all on a tree with insecticidal washes. Moreover, the meal-like powder which covers their bodies is impervious to light wettings with liquids, and the insects appear to possess unusual vitality. These facts make it necessary to use strong insecticides, and to apply them with great thoroughness. Resin wash answers best.

On several occasions Mealy Bugs have been present on citrus trees when I have fumigated these with hydrocyanic acid gas, to destroy the Red and other scale insects; and while all the other scales succumbed, the Mealy Bugs appeared none the worse from the treatment. When fumigating tender greenhouse plants much infested by them, they survived exposures to this gas that destroyed the foliage and young twigs. The gas is efficacious when used somewhat stronger than generally used for orchard fumigation, but the injury to trees is too serious if they are not dormant, to make the treatment advisable.

The popular treatment for the Mealy Bugs in greenhouses is to throw a forcible stream of water against them, and thus wash them from the plants. Few of them ever find their way back, though they are capable of travelling some distance; their wanderings are aimless, so if they finally reach the plant again it is by mere chance. This treatment is practicable out of doors if a heavy pressure can be given to the water. It is by no means a complete remedy, especially in the case of trees, since many of the insects and their eggs are forced further into crevices without being destroyed.

* *Agricultural Journal*, Vol. VIII. p. 548.

UNIV OF ILLINOIS

APHIDIDÆ OR PLANT-LICE.

General Characters and Habits.

The family of Plant Lice, or Aphides, includes a large number of species of which not a few are pests of considerable importance. All of them are small insects; probably none of them measure over one-quarter of an inch in length, and the great majority of them are very much smaller. The body is soft to the touch, and usually more or less pear-shaped in form, the hind part being the wider. The beak or proboscis, through which the insect imbibes the juices of the plant, is three-jointed, and is sometimes longer than the body. Both compound and simple eyes are generally present, and are well developed, except in the case of some root-inhabiting forms. The antennæ and legs are usually prominent. In many species, there is a pair of peculiar horn-like bodies called cornicles situated on the abdomen, and from these is discharged the sugary substance known as honey-dew, which has already been alluded to in treating of scale insects. Winged forms occur in nearly all species of plant lice. There are two pairs of wings, the front pair of which are larger than the hind pair.

The habits of plant lice are variable. Some live exclusively on the roots of plants; others, only on the parts above ground; and still others infest both the roots and stem. Those that live above ground are generally partial to the tender portions of the plant, like the foliage or blossoms, and young wood. Some, like the Woolly Aphis, however, may live on the trunk. Many species live in galls which they cause to form on the leaves like the aerial form of the Grape Phylloxera; and those that live on the roots of plants may cause an abnormal growth in these parts as the root form of the Grape Phylloxera and the Woolly Aphis.

Mode of Reproduction.

The mode of reproduction in plant lice is peculiar, and though some variations are exhibited among the many different species, the following generalizations may be made. As a rule, the majority of the insects in a colony are wingless females which reproduce without the intervention of males. These are known as the *wingless agamic form*. In many cases, this form gives birth to living young instead of laying eggs, a mode of reproduction often spoken of as *budding*. From time to time winged individuals of these peculiar females are produced; these are called the *winged agamic form*, and their province is to seek new feeding grounds. Their offspring are wingless agamic females. At times, sexual forms are produced; of these, the males may or may not have wings, but the females are supposed to be always wingless. After pairing, the true female lays one or more eggs. It is as these eggs that the insects usually pass the winter; they give rise to the agamic form again.

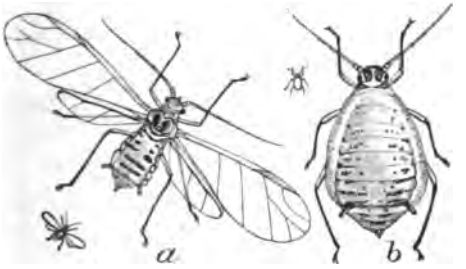


Fig. 23.—Cabbage Aphis, *Aphis brassicæ* Linn. A winged form and a viviparous female, much enlarged; natural size shown by small figures. (From U.S.A. Dept. Agr.)

The Aphides are remarkably prolific. It has been calculated that a single individual of some species may be the progenitor of many billions of young even within her lifetime of six weeks or less. Fortunate it is, then, that circumstances seldom favour this extreme propagation of the species; but the sudden appearance of enormous numbers of some species, such as the Rose Aphis in gardens and Woolly Aphis on the Apple, is explained by these capabilities to increase under favourable conditions.

How Aphides are Disseminated.

Aphides are disseminated in much the same manner as scale insects. Foreign species are introduced on plants or parts of plants, generally when in the egg stage and therefore when not easily detected, and when once introduced they are distributed over the country by a continuation of the same means.

The distribution locally is largely due to the winged forms of the insects which may be carried for long distances with the wind. It is generally agreed that the Phylloxera is spread in this way. This distribution by the aid of the wind takes place far more frequently in some species than others, largely dependent upon the numbers in which the winged forms are produced.

Injuries Inflicted.

The injuries inflicted by many species of aphides are not confined to those resulting from the mere loss of sap. Abnormal growths are sometimes set up in the tissues of the plant which result in malformations varying with the species of aphis causing them. It may be a curling and crinkling of the foliage, galls on the leaves, or knots and swellings on the roots and branches. Many species exude considerable quantities of honey-dew and thus indirectly injure the plants they are on in the same manner as honey-dew producing scale insects.

The direct injuries are sometimes sufficient to cause the death of the infested plant. Generally, the effect is less serious but retardation of growth is always the result. Almost every farmer knows the set-back which the Cabbage Aphis gives to cabbages and allied plants; and the dwarfed condition of the new growth of citrus trees infested by the Orange Aphis is a familiar sight.

Influence of Climate and Weather.

The aphides show a preference for temperate climates even more decided than scale insects. Violent changes in temperature are fatal to enormous numbers. As a rule,

they are most abundant in moist, sheltered situations. Cold rains or heavy showers sometimes almost exterminate those on exposed plants; and, indeed, they are so susceptible to changes in the weather conditions which are unfavourable to them, that they would be insects of little economic importance were it not for their equal capacity to respond to favourable conditions. Many species thrive well only on the new and tender growth of their food plants, and when this growth hardens with the advancing season or during a dry spell, they become scarce until there is a change to their advantage.

Natural Enemies.

The natural enemies of aphides are similar to those of scale insects, many of the predaceous enemies of the latter attacking aphides as well. The lady-birds which attack aphides in this colony are more numerous as regards species than those which prey upon scale insects. The most common species is *Chilomenes lunata*, Fabr. It is the largest of our predaceous lady-birds and measures slightly more than one-fourth of an inch in length. The ground colour of the wing cases varies with age from clear yellow to clear red, and is enclosed by more or less complete patches by linear black markings. A narrow strip of the black margins the wing cases all around. The Yellow Lady-bird is a common enemy of the species of Aphis on Oak. Aphis-lions and Syrphus-fly larvæ are usually abundant among aphides and sometimes suffice to hold them in check. The birds known as White Eyes have been noticed to peck among them and are supposed to devour a few. Internal parasites destroy a large number; aphides infested by them are generally recognisable by the swollen condition of the body often coupled with a change in colour. After undergoing its transformation to a winged insect, the parasite cuts a hole through the skin of the back and escapes. The dried skins of aphides perforated by the holes made by escaping parasites are often very common among the well-known species which attacks citrus trees.

Remedies.

Most aphides are easily destroyed. But many because of secretive habits require special treatment, and it may be even impossible to hold them in check by direct measures. Moreover, as they are prodigiously prolific, a plant may become badly infested again within a short time if their destruction is not complete.

Most aphides will succumb to water containing one pound of soap to four gallons. Paraffine emulsion, diluted with 15 to 20 parts of water will accomplish the same result, and being of a more penetrating nature, is more certain to be effective when the insects are massed together or partially secreted. Resin wash is excellent for the purpose, and is efficient when diluted with double the usual quantity of water, and in the case of some species, even when diluted with three times the usual quantity. The carbolic sheep dips are probably all effectual, and a little experience will prove the strength at which any particular one had best be employed. An infusion of tobacco kills as well as any insecticide, but costs a good deal in this country; one pound of tobacco is steeped in one and a-half gallons of water for a day or two. Against those aphides that infest the terminal growth only, it is often possible to economize with the insecticide by bending over the branches and immersing them in the liquid.

Root-infesting aphides are difficult pests to contend against. Exposing the roots and drenching them with scalding water [see page 112] is often the best measure when it is economical to employ any. Digging gas-lime or tobacco stems into the soil above the roots is recommended by many writers and said to be at least partially effective; but these substances are not to be had in most portions of this country. The use of carbon bisulphide as against the Phylloxera has also been suggested; this, too, would prove an expensive remedy, and one which few fruit growers would adopt.

There is one aphis (*Myzus persicæ*) which attacks and deforms peach leaves, causing them to curl and thus shelter the aphides from insecticides. This species is present to at least a slight extent in some portions of the colony. If

it ever becomes a serious pest, it may be possible to combat it with poisonous vapours, such for instance as tobacco fumes generated beneath a tent after the manner in which citrus trees are treated for the Red Scale. Cheaper and lighter tents would probably suffice.

Woolly Aphis.

(*Schizoneura lanigera*, Hausman.)

Name.—The popular name of this insect in England and in many parts of the colonies is "American Blight." In this colony, the name given in the heading is almost equally common, and I give it the preference because it is somewhat descriptive of the insect. A few farmers call it "Blood Insect" because of the reddish stain which is yielded when the insect is crushed. "Apple-root Plant Louse" and "Woolly Louse" are names used by some authors.

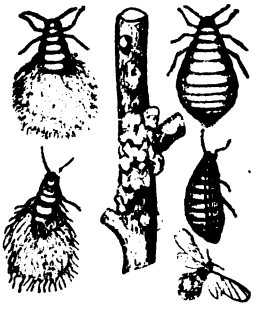


Fig. 24.—Woolly Aphis, *Schizoneura lanigera*, Hausm. Insects on the bark, and individuals enlarged. (From U.S.A. Dept. Agr.)

Distribution.—Many English and Continental entomologists have claimed that this insect is of American origin, hence the name "American Blight" that has been alluded to; while some of the best American entomologists are positive that it was introduced into their country from Europe. Whatever country may be responsible for its origin, it has been known in Europe for over a century, and is now found on all the continents of the world, and wherever it has appeared it has proved a pernicious pest.

Saunder's, in his "Insects Injurious to Fruits," states that it appears to thrive only in comparatively cold climates, but the experience of this colony and of Australia also will not bear out this statement. Its ravages in all countries seem to have been greatest shortly after its introduction. In the early part of this century it destroyed immense numbers of trees in England, but at the present day it is not regarded as a very serious pest. Likewise in America, it is much more injurious now on the Pacific slope, where the orchards are comparatively young, than on the Atlantic sea-board, where it was a pest of prime importance 50 to 75 years ago.

Occurrence in Cape Colony.—The Woolly Aphis is the most serious enemy to the Apple that we have, with, perhaps, the single exception of the Codlin Moth; and while the latter insect is limited in its occurrence, the Woolly Aphis appears to be common throughout the colony. Moreover, the Codlin Moth affects the fruit only, while the Woolly Aphis directly affects the vitality of the tree, and thus indirectly affects the fruit as well as the growth of the tree itself. Most of the complaints about the insect which reach the Agricultural Department come from the eastern parts of the colony, and perhaps these sections suffer most from it.

Food Plants.—The Woolly Aphis is primarily an Apple insect. Buckton, in his "British Aphides," mentions that it has been found on the native crab-apple in America; and Matthew Cooke in his "Injurious Insects of the Orchard, Vineyard, &c.," mentions it in a list of insects which attack the Pear. Recent Californian horticultural papers have contained references to a "Woolly Root-louse," which has become extremely injurious to young pear trees in several localities in that state. It seems to be generally accepted that the insect is identical with the Woolly Aphis of the Apple, but as yet I have seen no authoritative confirmation of this point. The only instance in which I have seen the insect on Pear was in the garden of Rev. Andrew Murray at Graaff-Reinet; here a few of the suckers and twigs of a large Easter

Beurre which grew in the proximity of an infested apple tree were slightly attacked. Knotty malformations like those formed on Apple were present. The roots of the tree were not examined. All varieties of Apple are not equally susceptible to the attacks of the insect, and a few varieties have proved to be altogether exempt.

Description and Habits.—The insects are variable in colour, but are generally brownish-black; they are oval in form, and when fully developed measure from one-sixteenth to one-tenth of an inch in length. The adults exude large quantities of a white, cotton-like substance in the form of long threads, the mass often entirely concealing the body; the young, also, secrete this cotton-like substance, but not in such abundance. It is this exudation that gives the the insect its common name, Woolly Aphis.

There is a succession of generations throughout the year, the young for the most part being produced alive and in immense numbers from the wingless mothers. At times, winged females are developed. This winged form is not very common, and is most abundant at the approach of winter. It has been collected near Cape Town in the middle of March. In Europe and America it is said that eggs are deposited late in the season, and that it is these eggs that give rise to the swarms of insects that appear in the spring. It is probable that this winter-egg stage occurs in this colony, but, as yet, it has not heen observed. In the south-western part of the colony, living insects may be found throughout the year; trees which were quite white with them were observed last August.

The Apple is attacked both above and below ground by the Woolly Aphis. In America, most complaint is made of the injuries to the roots of the trees, while in Europe, the injuries above the soil appear to be deemed of greater severity.

Places on the branches that have in any way been bruised or injured are especially liable to be attacked. This preference is not so noticeable on the roots. Suckers from the roots and branches, and the collar of the tree, are also favourite points of attack. Wherever they infest the tree, their attacks cause an abnormal growth in the plant tissues,

and wart-like swellings of considerable size are formed. The surface of these is very uneven and furnishes numerous crevices in which the insects may become partially secreted. On the stem of the tree, these processes harden; but on the roots, perhaps owing to the naturally moist conditions of these parts, they decay and thus may cause the destruction of all the surrounding tissues to the great additional injury of the plant.

Enemies.—In all the countries where the Woolly Aphis has been known for a long period, its destructiveness has gradually lessened owing to the increasing abundance of natural enemies. These enemies are not the same in all countries, but are largely native parasites and predaceous insects which have learned to prey upon it. The most useful enemy at the Cape seems to be the Shining Black Lady-bird. This little beetle has a wide distribution in the colony, and in a few orchards is said to keep the aphis in check without the assistance of artificial remedies.

The Variegated Lady-bird (*Thea variegata*, Fabr.) is also useful in destroying the Woolly Aphis. This beetle is about one-eighth of an inch in length. It is yellow in colour and marked with numerous black spots which are arranged in regular rows on the back. There are two of these spots on the head; then five in two rows on the thorax; and then follow, on the wing-cases, one row of four spots, then one of six, then one of five, and lastly one of two. Those in the row containing six are largest of all and are longer than broad; and the middle one in the row of five is divided by the suture between the wing-cases.

The Yellow Lady-bird is frequently found in colonies of the Woolly Aphis, and very likely feeds to some extent on the insects. Occasionally, spiders are seen to devour a few, and now and then the larvæ of a species of Syrphus fly are seen to be engaged in a similar manner. These larvæ taper almost to a point at the head and are thick and blunt behind. They are generally of a greenish colour, and when full-grown are about three-eighths of an inch long. The hind part of the body remains almost stationary, while the fore part lashes about among the aphides; these become caught upon the peculiarly pointed mouth-parts and are held there while being sucked dry.

PLATE III.

Woolly Aphis, *Schizoneura lanigera*, Hausm.
An infested apple twig.

Preventives.—The recognised fact that certain varieties of Apple were not attacked by the Woolly Aphis suggested the use of these varieties for stock purposes; and in Australia, where such "blight-proof" stocks were first employed, they are said to have now come into very general use. These stocks secure immunity to the roots, but not to the parts above the graft or bud. These are just as liable to attack as if the roots were not blight-proof, but as the insects which infest the roots are much more difficult to contend against than those on the stem, the advantage of blight-proof stocks is very great. Mr. Charles French, the Entomologist of Victoria, in his work entitled "Destructive Insects of Victoria," writes as follows: "Before the advent of those excellent blight-proof stocks, the 'Majetin' and 'Northern Spy,' it was exceedingly difficult to find, in most orchards, an apple tree that was clean or in perfect health; now, with a little care and attention, the fruit grower, as a rule, may snap his fingers at the 'American Blight,' as, even if it should appear, it can now be kept within reasonable bounds, if not stamped out altogether." In the younger colony of Western Australia, as well, these stocks are used with excellent results. The Journal of the Bureau of Agriculture of that colony in its issue for February 18th, 1896, contained the report of the Entomologist on a visit to a certain section of the colony, in which the statement was made with reference to the Woolly Aphis that, "owing to the extensive use of blight-proof stocks, the district appears to be entirely free of the pest."

The use of blight-proof stocks has been agitated by the Department for Agriculture of this colony, and young trees on such stocks may now be purchased of several colonial nurserymen. The supply of these trees at present available is, however, very limited. It costs the nurserymen somewhat more to grow trees on these blight-proof stocks than on seedling stocks, and, therefore, intending purchasers should be willing to pay a higher charge. The most common method in vogue for securing blight-proof roots is to graft a piece of blight-proof branch on to a piece of blight-proof root, and then to later graft or bud the desired variety on to the stock so produced. This

"double-working" of stocks is comparatively easy under some climatic conditions, but is said to be difficult in the drier sections of our colony.

There are a large number of varieties which are wholly or partly blight-proof. A list of these was published in the *Agricultural Journal* for September 19th, 1895. The Northern Spy and the Winter Majetin are generally acknowledged to be the best. Apple growers in this colony have frequently remarked that a variety long grown in the colony and known to them as the "May Apple" is not susceptible to the attacks of the insect.*

Remedies.—The root-infesting aphides are best destroyed by thoroughly drenching the infested parts with hot water after removing a few inches of the surface soil. Boiling water will injure the roots, but as the temperature of the water is considerably lowered by contact with the atmosphere and soil, the roots are seldom injured even if the temperature of the water is 200 degrees Fahrenheit when it is poured upon the ground. Resin wash, paraffine emulsion, tobacco water and sheep dip when used in the same manner are more reliable as they may kill the insects by virtue of their insecticidal properties if their heat is insufficient for the purpose. Unless the trees are small, some of the insects are almost sure to escape, and so repetitions of the application are necessary from time to time; hence, unless it is thought that extermination is possible, the hot water treatment is the more economical.

The aphides are less difficult to destroy when they infest the exposed parts of the tree; but owing to their habit of frequenting crevices and wounds in the surface, often being located beneath loose bark, it generally happens that some of the insects escape and remain to "increase and multiply." The insects yield readily to insecticides, and, therefore, success depends almost wholly upon the thoroughness of the application of the insecticide. The loose bark should be removed, and the utmost care be taken to wet every portion of the surface which may har-

* Particulars of blight-proof stocks and the method of "double-working" them is fully explained in the "Manual of Practical Orchard Work," by MacOwan and Pillans, published by the Department of Agriculture.

bour the pest. Applying the insecticide with a brush is preferable to applying it with a spray pump in most cases as the crevices are then treated with greater certainty. The failing with most growers is that they overlook small clusters of the insects; these small clusters become the progenitors of large colonies. The appearance of the insect in numbers leads the grower to think that his treatment was not effectual and that a stronger insecticide is necessary when the chances are that all that he "dressed" were destroyed.

Numerous insecticides have been recommended for destroying the Woolly Aphis, and owing to the fact, already stated, that the individual insect is easily destroyed, most of them are more or less effectual; but few equal and none are superior to well-made paraffine emulsion. This may be diluted to the normal strength or used somewhat stronger. As it does not require much insecticide to brush over the infested parts, the expense is trifling.

I once had two small and badly infested trees covered with tents and fumigated with hydrocyanic acid gas in the same manner as citrus trees are treated for the destruction of the Red Scale. All of the aphides appeared to be destroyed; but in a short time, the lower parts of the trunks became again infested and in a few months, the insects were almost as numerous on the branches as before the treatment. If the trees had been on blight-proof roots, I believe the insects would have been exterminated.

It is an almost impossible task to thoroughly clean large trees which have long been badly infested and thus have become covered with the wart-like excresences, especially if the roots are attacked. In such a case it is most economical to occasionally dislodge the insects by throwing a forcible stream of water against them. It is a mistake to leave suckers and superfluous growths on such trees under the impression that the insects will seek these parts. The immense numbers which are found on such growths are not drawn from other parts of the tree. They are developed where they are found, the succulency of the parts doubtless inducing greater prolificacy in the insects and sustaining a larger proportion of the young produced than if these were born on harder and less favourable por-

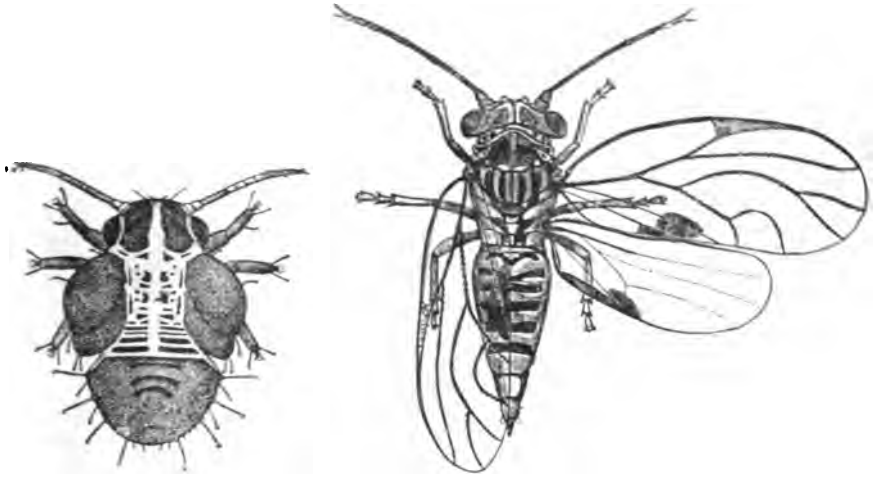
tions of the bark. The insects which develop unmolested in such situations in time would give rise to a winged generation thus furnishing nuclei for many new colonies. If it is proposed to plant young apple trees in the vicinity of infested old trees, the cutting down of the latter should be considered seriously; in many cases, it would be policy to remove them.

The introduction of this pernicious pest into nearly all countries has been by means of infested nursery stock, and its subsequent spread in these countries has been chiefly through the same agency. At the present time, the insect is prevalent in many of our colonial nurseries; and, although most of the trees appear to be clean when they leave the nurseries, many of them bear a few of the insects. These may be apparent if the trees are examined, but may escape casual observation; and as it is best to be on the safe side in a climate in which the insect may cause as much trouble as it does here, it is a wise precaution to immerse dormant nursery stock for a minute or two in paraffine emulsion diluted to normal strength and heated to a temperature between 130 and 140 degrees. This will destroy any aphides which are present.

When a few young trees are found infested in an isolated orchard, no chance of the insect spreading to the other trees should be permitted. The best plan would be to destroy the infested trees where they stand and not to replace them with apple or pear trees within a season.

PSYLLIDÆ OR JUMPING PLANT LICE.

This is a smaller family than either the Scale Insects or the Aphides. In many respects, the adults resemble aphides but may at once be distinguished by their power of jumping. They are provided with two pairs of wings. Reproduction takes place in the manner normal among insects; and the species are, as a rule, exceedingly prolific. They subsist, as do scale insects and aphides, on the juices



a *b*

Fig. 25.—Pear Psylla, *Psylla pyricola*. *a*, immature form; *b*, adult female with wings on one side shown open, and on the other in their resting position; both figures are greatly enlarged, the mature insect measuring but about one-tenth of an inch in length. (Taken from figures by U.S.A. Dept. Agr.)

of plants. Many of the species exude honey-dew, and some cause malformations of the foliage. They are disseminated by the same agencies as the insects previously discussed; but as they possess wings, it is reasonable to suppose that local distribution is accomplished with greater rapidity.

The Blue Gum Louse (*Rhinocola eucalypti* Maskell),* which is, apparently, a common insect in all parts of South Africa where the Blue Gum is grown, is a member of this family. This insect is undoubtedly an importation from Australia, and it has been widely distributed on nursery

* Determined by E. A. Schwarz.

stock. As far as known it infests only the Blue Gum. It is almost wholly confined to the sessile foliage and, therefore, is much more common on young trees than old ones. The eggs are laid in the tips of the new growth.

The Pear Psylla (*Psylla pyricola*) is, probably, the most destructive member of the family of interest to fruit-growers. Fortunately, it is still unknown in Cape Colony. It has found its way to the United States from Europe and has become extremely destructive in many large pear orchards. Its spread through the country has been proved to be almost entirely due to infested trees from nurseries. One instance is recorded of an orchard eleven years planted and wholly free of the pest being found within half a mile of another orchard which had been infested for fifteen years. Pear trees of all varieties and ages are said to be attacked. The presence of the insect is indicated by the black fungus which grows on honey-dew, copious quantities of this substance being exuded. As pear stocks are imported from France, it is not unlikely that this pest will find its way to this colony; indeed, it is not improbable that it already exists somewhere in the country.

Citrus Psylla.

The insect to which this euphonious name is assigned is a species of *Trioza.** It was first observed on some young trees which had been brought from the eastern part of the colony and planted at Stellenbosch. Subsequently, it has been found at several places in the Midland districts but in every case thus far observed, the infestation is traceable to one nursery. There it has occurred for a number of years, but from where it came originally and how long it has been in this nursery are questions which remain unanswered.

Food Plants.—It is known to attack Orange, Lemon, Citron, Shaddock, Naartje, and Bitter Seville Orange, and so can, probably, subsist upon any variety of citrus tree. Thus far, it has not been observed upon plants of any other genus.

Description and Habits.—The eggs are generally deposited along the edges of expanding leaves. These

* Determined by W. M. Maskell.

eggs are yellow in colour and oval in form, and have a short, stem-like projection at one end. The young larvæ crawl on to the under surface of the leaf and settle; and it appears that wherever one settles and begins to draw nourishment from the leaf, a pit-like depression slowly forms. The young insects fit nicely into these depressions

Fig. 26.—Twig from lemon tree showing leaves distorted by the Citrus Psylla.

and are not especially conspicuous. They are pale yellow and bear a superficial resemblance to the young of the Brown Scale, but can at once be distinguished by the presence of a short and delicate fringe about the body. This fringe is composed of a great number of straight, white, waxen filaments of equal length. The eyes are red-

dish and quite large; they are easily seen through a low power magnifying glass, as are also two slightly larger, widely separated, brownish spots on the abdomen. During this stage, the insects are capable of moving about but, apparently, do not often choose to do so. Finally, these scale-like bodies develop into winged insects. These winged insects are very active, both at jumping and flying. When settled, they look, to the unaided eye, very much like ordinary plant lice.

The young growth of the plant is the only part attacked by this insect. The pits or depressions which they cause are conspicuous, and form a good index to their attack. These pits are sometimes found somewhat removed from the terminal growth, where they are also present; the pits on the older leaves, however, contain no insects. Presumably the pits on the older growth were formed and inhabited when these leaves were terminal, and the insects, emerging from these pits, swarmed to the younger growth which by this time was separated from the pitted leaves by several perfect leaves.

Injuries, Remedies, and Enemies.—The injury caused by this insect, aside from some interference with the respiratory functions of the foliage caused by the pit-formations, does not appear to be greater than what would be caused by the attack of the species of aphis common to citrus trees. There appears to be no exudation of honey-dew, and, consequently, no growth of the soot-like fungus due to its presence. All things considered, this does not appear to be a dangerous pest; but still its presence is undesirable, and it retards the growth of the trees. Therefore, infested trees should be cleansed before they are planted, or better yet, should not be planted at all. It is said, by the nurserymen on whose premises it occurs, to yield readily to tobacco infusion or paraffine emulsion; but the surest way of eradicating it is to keep the pitted leaves and infested terminals picked from the trees.

The only natural enemy which has been noticed to prey upon it is the larva of a Syrphus fly. A number of these were once present on some infested leaves mailed to me for examination, and on the way they had devoured nearly all of the psyllids.

ACARINA OR MITES.

The mites are distinguished from insects and other allied forms of life by having the abdomen fused directly to the thorax in all stages, and in lacking segmentation in this part of the body. Most of the species are very small; but some of the Ticks and Harvest Mites become a third of an inch or more in length. Prolificacy is a rule in the family. The food habits vary widely. Some are parasitic on animals, as the Ticks. Some are parasitic on insects: familiar examples are the tiny, red mites often found attached to the wings of locusts, and also those found on the Calandra of the Vine. Some are found in food products, like the Cheese Mites, and those so common on dried fruits, especially imported prunes and figs. Many are found in decaying wood and other vegetable matter, and still others attack living plants.

It is a few of the last class that are to be discussed. The first, the Red Spider, belongs to a section called Spinning Mites, from the fact that its members shelter themselves with a fine web of silk. The second, the Bryobia Mite, belongs to a section called Harvest Mites. Little is known of the majority of Harvest Mites, but they have very diverse habits. Two members of the section are probably familiar to most colonists; these are the mite which is found attached to locusts, and the comparatively large, velvety, bright red creature that swarms on the Karroo veld after rains. The third and last is the Pear Leaf Blister Mite. This belongs to a group called Gall Mites. They are extremely minute, and differ from other mites in possessing but two pairs of legs. Other kinds have three pairs when hatched, and four pairs in later stages. Some species of Gall Mites live in the buds of plants and cause considerable damage; others, like the one to be considered, live in gall-like swellings which they cause to form on the foliage.

Red Spider.
(*Tetranychus* sp.)

Name.—"Red Spider" is the popular name among gardeners for the tiny, reddish mites which swarm on the surfaces of leaves of various plants. A number of species have been described. I am not positive that all those which occur in the colony are of one species or whether or not they are identical with any described species; but I suspect that in most cases at least, they are identical with the Common Red Spider (*Tetranychus telarius* Linn.) of other countries.

Distribution, Food Plants, and Injuries.—Red Spiders seem to be known in all parts of the world. They thrive best in warm, dry situations, and, consequently, they are common greenhouse pests, and are destructive in warm, dry climates. Sudden changes in temperature and heavy rains are fatal to large numbers. It is recorded that the common species (*T. telarius*) has become extremely abundant and injurious in parts of Chile, but that it is unknown in the southern sections of the country where rains are frequent.*

Matthew Cooke states that the same pest has spread to an alarming extent in Californian orchards, and that nearly all deciduous fruits and also citrus fruits are attacked.† The same species is reported to seriously injure fruit trees in the drier portions of Victoria, and what may be the same is pronounced a pest in Queensland.

Only local reports of damage to fruit trees by the Red Spider have reached me during the past year, and I cannot say how widely it is spread in the colony, or whether or not it occasions much damage to fruit trees where it does occur. It is common in the vicinity of Cape Town on fruit trees, particularly on the Plum. Melons, Beans and other vegetables, and Cape Gooseberry (*Physalis peruviana*) suffer more severely; in fact, the latter plant is much

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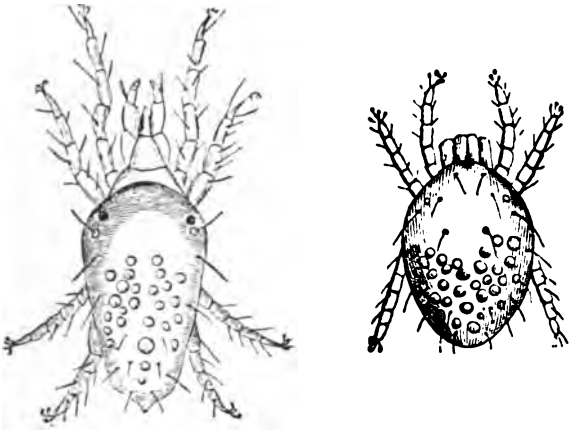
* Insect Life, Vol I., p. 155.

† Injurious Insects of Orchard, Vineyard, &c., p. 254.

injured, not only about Cape Town but in other parts of the Western Province, and also in the eastern parts of the colony.

Mr. W. G. Alston is authority for the statement that the Red Spider appeared on Melons at Van Wyk's Vley (Carnarvon) in 1895, and that it shortly afterward was noticed to have spread to the veld; the bush called the "Drei-doorn" suffered the most severely. The mites did not appear on the same ground during the following season, but infested patches of the veld an acre or less in extent were found some distance to the south.



a *b*

Fig. 27.—Red Spider, *Tetranychus telarius* Linn. *a*, adult male; *b*, immature mite; both figures greatly enlarged. (From Murray's "Aptera.")

Description and Habits.—Full-grown mites from the Cape Gooseberry measure one-sixtieth of an inch in length. As far as I have observed the colour is red but variable in tint and intensity. In other countries, the common Red Spider is described as very variable, in colour and sometimes inclining to green. Some of the eggs on the Cape Gooseberry are almost colourless, while many are red; the difference is probably due to difference in development.

The web of silk spun by the spiders on the Drei-doorn bush is said to glisten in the sunlight and to be thus made visible from the distance of a mile.

These mites are provided with pointed mandibles which they use for cutting into the surface of the leaves; they then suck the juices through these wounds. (Murray.)

Enemies.—A small black lady-bird is said to attack the Red Spider at Van Wyk's Vley. Other species of lady-birds which attack it have been observed in various parts of the world, but lady-birds do not seem to be very formidable enemies to it. Murray states that the larvæ of lace-winged flies devour them in great numbers.* Drenching rains are the great check. A heavy summer shower will destroy them by myriads.

Remedies.—The Red Spider is a difficult pest to deal with out-of-doors when it badly infests plants; not that it possesses unusual vitality, but that it multiplies with such great rapidity under favourable weather conditions that it maintains its hold on the plant. The fine web of silk doubtless shelters many from insecticides even when these are carefully applied. Sulphur is generally regarded as being particularly efficacious, and is used in a variety of forms. Sometimes it is simply dusted over the infested trees, but is, perhaps, more frequently applied in a dissolved form by means of a spray pump. An allied mite (*T. 6-maculatus* Riley) which attacks citrus trees in Florida, is combated to some extent by a compound made of caustic soda and sulphur. Several parties have promised to experiment with this against our Red Spider, but as yet I have received no report of its use. The directions for making this compound are given on page 134.

Paraffine emulsion destroys any with which it comes in contact, and to a lesser extent soap solutions are valuable. But owing to the spiders being present in such enormous numbers, and on the underside of the foliage which is much more difficult to thoroughly spray than the upper surface, enough escape to make repeated applications of the insecticide necessary to keep them in check. I know of no one who has been successful in battling with them on the Cape Gooseberry, with any substance. The foliage

* Economic Entomology, Aptera, p. 100.

of this plant is covered with a hirsute growth, and hangs in a manner which makes perfect under-spraying practically impossible. The same obstacles are presented by melon vines. It is highly probable that fumigation with the fumes of carbon bisulphide would destroy the insects without injury to the plants, and that this treatment could be economically carried out on the Cape Gooseberry, as the fruit of this plant is in good demand at paying prices. Hydrocyanic acid gas would probably prove less valuable for the purpose.

Bryobia Mite.

(*Bryobia* sp.)

Name.—The specific identity of this mite has not yet been established, but there is great probability of its being *Bryobia pratensis* Garman. If it is not this species it is a closely allied one; the chief distinction is one of dimensions, the specimens of the present species which I have preserved not being over two-thirds the given length of *B. pratensis*; but, not unlikely, these specimens are undersized, a supposition in part confirmed by the eggs measuring precisely the same as those of the named species.

Occurrence in Cape Colony.—Specimens of this mite have been sent to me from various places in the Cape and adjacent districts, from Oudtshoorn, Graaff-Reinet, and from Ficksburg (O.F.S.). As these places are widely separated, it is expected that the mite occurs in many other districts as well.

Distribution of Species of Bryobia.—Species of *Bryobia*, of similar habits to our own, occur in Europe. The species mentioned above, *B. pratensis*, is recorded to occur in widely separated sections of the United States, both East and West. There it has become known as the Clover Mite, from its ravages on this important fodder crop. One species is recorded in Queensland, one in New Zealand, and one in Victoria; the latter is referred to under the name of a European species, *B. speciosa*. And in the *New*

South Wales Agricultural Gazette for September, 1896, is a note on a species of mite, apparently common in that colony, that evidently refers to a species of this genus. The habits of the species of *Bryobia* are such that they are undoubtedly distributed on nursery stock, and there is

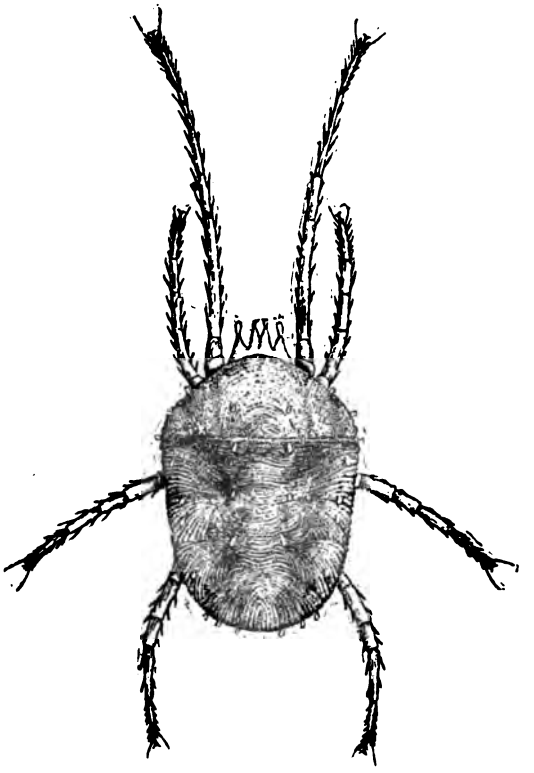


Fig. 28.—Bryobia Mite, *Bryobia pratensis* Garman. Adult mite, greatly magnified. (Redrawn from "Insect Life.")

some reason for suspecting that the species common in several countries are identical.

Food Plants.—All of the specimens received at this office have been on Pear or Plum. In the United States, the Clover Mite is found on a great variety of plants, including Apple, Pear, Peach, Almond, Plum and Prune

among the fruits. In New Zealand, Apple is mentioned as the food plant; in Victoria, the stone-fruits and Apple; in Queensland, the Peach and the Grape.

Description and Habits.—The mites superficially resemble the Red Spider, but are fully twice the size; still, they are appreciable to the unaided eye only as tiny, red-coloured specks. When magnified, four pairs of long legs are seen which explain the activity of the speck; the first of the four pairs is considerably longer, and the other three are somewhat shorter than the body.

The eggs are large in proportion to the adult. They are bright red in colour and almost spherical in form. It takes 125 of them placed end to end to measure one inch. They are deposited in the fine creases of the bark on the young twigs and at the forks of the young shoots by preference, but are often to be found all along the under side of the branches and on the trunk, sometimes in such extreme abundance as to give these parts a distinctly reddish hue. Although usually placed singly, they may be in two or more layers when they are abundant. When the young hatch, it is seen that the egg shells are whitish. Generally, large numbers of living mites may be found among the eggs during the winter.

The food habits resemble those of the Red Spider. The lower surface of the leaves are infested and the plant juices extracted through lacerations made in the surface. The leaves become mottled in appearance and drop prematurely when badly infested.

Injuries.—No cases of more than a few much-infested trees at any one farm have come under my observation; some correspondents, however, write as though many of their trees suffered great injury.

Clover and certain grasses are said to sometimes suffer very severely in some sections of the United States from *B. pratensis;* the foliage turns yellow and the plants cease to grow. From the reports published in some of the rural papers of the western states, it is inferred that much damage is there occasioned to many pear, peach and plum trees; though on the whole the impression is left that it is

one of the minor pests of the orchard. An American entomologist, after a visit to Victoria (Australia), wrote that "What is known as the Bryobia Mite (*B. speciosa*) is quite injurious to stone-fruit trees, and also to the apple tree."

Remedies.—The Bryobia Mite can best be combated during the winter. If left unmolested until the leaves unfold, it will probably cause a large proportion of its injuries before it can be checked. One tree which was very much coated with eggs during the past winter was given a thorough spraying with lime-sulphur-salt wash. None of the eggs hatched so it is inferred that the insecticide was successful in destroying them. Either paraffine emulsion or resin wash will destroy the mites, and perhaps the former will penetrate and destroy the eggs. Probably the soda-sulphur wash would, also, destroy the mites.

One correspondent, at my suggestion, dusted badly infested trees with sulphur, and subsequently reported that while the trees appeared to have been benefited by the treatment, great numbers of the mites survived. In this case, the sulphur was applied when the trees were dry.

It seems probable that heavy rains annihilate almost every one of the mites on badly infested trees. During last spring, two plum trees were found almost smothered with the mites, and it looked at the time as if all of the foliage would be destroyed, some of it already having fallen; but on visiting the tree a few weeks later and after a heavy fall of rain, I was surprised to find that nearly every mite had vanished. If the mites are really so susceptible to a thorough drenching, a few heavy sprayings with clear water might answer as well as the application of an insecticide.

Pear Leaf Blister Mite.

(*Phytoptus pyri*, Scheuten.)

Distribution and Food Plant.—This mite is said to be common in European countries. It is now found in many parts of the United States and Canada, and in several of

the Australian colonies. The indications are that it has spread from Europe on nursery stock.

It is believed to attack all varieties of Pear, but that it will attack any other plant appears doubtful.

Occurrence in Cape Colony.—It has been found at a number of places in the Western Province of the colony, including two or three nurseries. In all cases thus far observed, only young or newly grafted old trees have been infested, which would seem to indicate that it is a pest of recent introduction. The mites hibernate in the buds and hence are easily transferred to other trees by grafting or budding. In this way, a whole nursery of young Pears might be infected from a few trees.

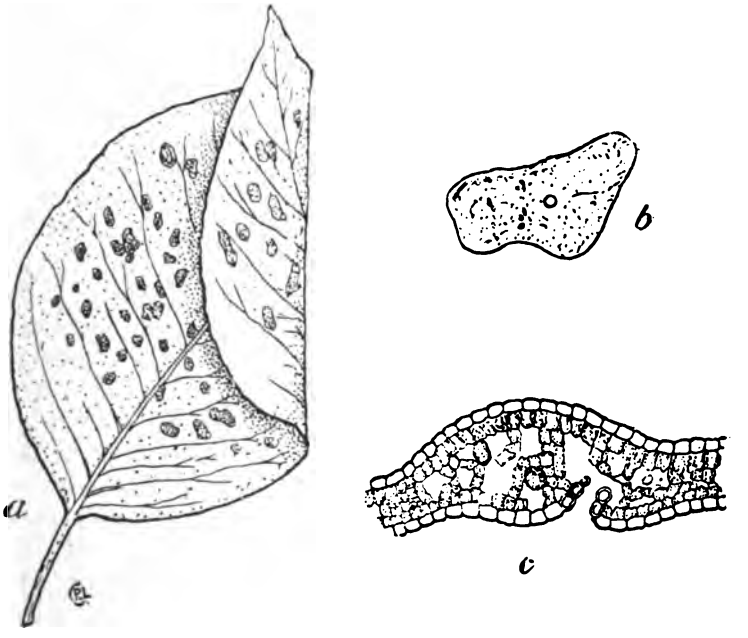


Fig. 29.—Pear Leaf Blister Mite, *Phytoptus pyri*, Scheuten. *a*, leaf, showing blisters; *b*, single blister from beneath; *c*, section through a blister, showing eggs. (*a* and *b*, original; *c*, redrawn from Cornell Bulletin, 61.)

It is not known, definitely, that it occurs in the eastern parts of the colony; but some of the infested young trees found in the Western Province are said to have come from an Eastern Province nursery.

Description and Habits.—The effect of the presence of the mites is much more apparent than the mites, themselves, for they are hardly discernible with the unaided eye. These effects are blister-like swellings of the portions of the leaves infested by them. The leaves are attacked while yet in the bud, and some of the blisters appear with the leaves. At first, these blisters are reddish in colour and most noticeable on the upper surface of the leaf. Later, the reddish colour fades away and the blister passes through different shades of green and gradually becomes brownish or black. The blisters are not very regular in outline but, generally, are as long as broad. They vary in size with a diameter of less than one-eighth of an inch. Sometimes a number of blisters become coalesced. The mites may be found within the tissues of the blister, and a small entrance hole is present near the middle on the lower surface of the leaf. The changes in the colour of the blisters is due to the disintegration of the underlying tissues.

It takes about forty of the mites placed end to end to cover a line one-quarter of an inch in length, and they are not over one-fourth as broad as long. They have but two pairs of legs and these are situated at the fore end of the body. It is said on good authority that the mites instinctively migrate from the leaves as soon as these become dry, and then secrete themselves beneath the scales of the buds which are to expand the following season.

Injuries.—The blisters interfere with the respiratory and assimilative functions of the foliage, and this interference must result in a serious diminution of the nourishment which would normally be accumulated in the buds when the blisters occupy the greater part of the surface as they frequently do. Leaves very much affected may drop long before the natural time.

Remedies.—Sulphur has been recommended as a remedy for this mite in Pacific Coast horticultural journals, but owing to the fact that the mites live and breed within the tissues of the leaves and migrate to the buds and are there secreted during the dormant season, it seems improbable

that sulphur can prove efficacious in destroying them when applied in a powdered form to the foliage as is suggested. At my request, a few infested trees were thoroughly dusted with sulphur late last summer, and this spring, the blisters on the foliage were quite as numerous as they were last season. Experiments conducted at the Cornell Experiment Station of New York proved that a single application of paraffine emulsion diluted with five to seven parts of water destroyed nearly all of the hibernating mites. An attempt to duplicate these experiments is reported on page 12; the indications are that the treatment found efficient in New York is successful here, but further tests are needed to remove slight doubts.

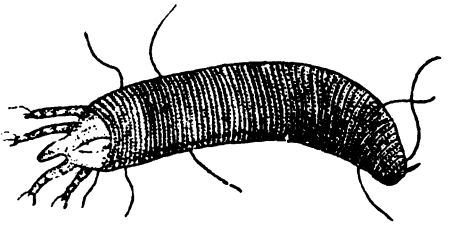


Fig. 30.—Pear Leaf Blister Mite, *Phytoptus pyri*, Scheuten Adult mite, greatly magnified. (Redrawn from Cornell Bulletin, 61.)

A number of trees which were last year affected by the mites were sprayed during the dormant season with lime-sulphur-salt wash and no blisters appeared this spring on the sprayed trees, while unsprayed surrounding trees are somewhat attacked.

DETAILS OF REMEDIES.

Specific mention of the remedies suggested for the different pests which have been considered have been given in the text, but the directions for preparing the insecticides, and general instructions have been reserved for notice here.

The imperial gallon is the standard for liquid measure in the colony, and is the measure intended for use in the formulæ here given; those taken from American sources have been altered to conform to this standard. The American gallon contains 231 cubic inches, while the imperial contains 277 and a fraction; for rough calculations, 4 imperial gallons are considered the equivalent of 5 American gallons. An imperial gallon of water weighs 10 ponnds at ordinary temperature at the sea level.

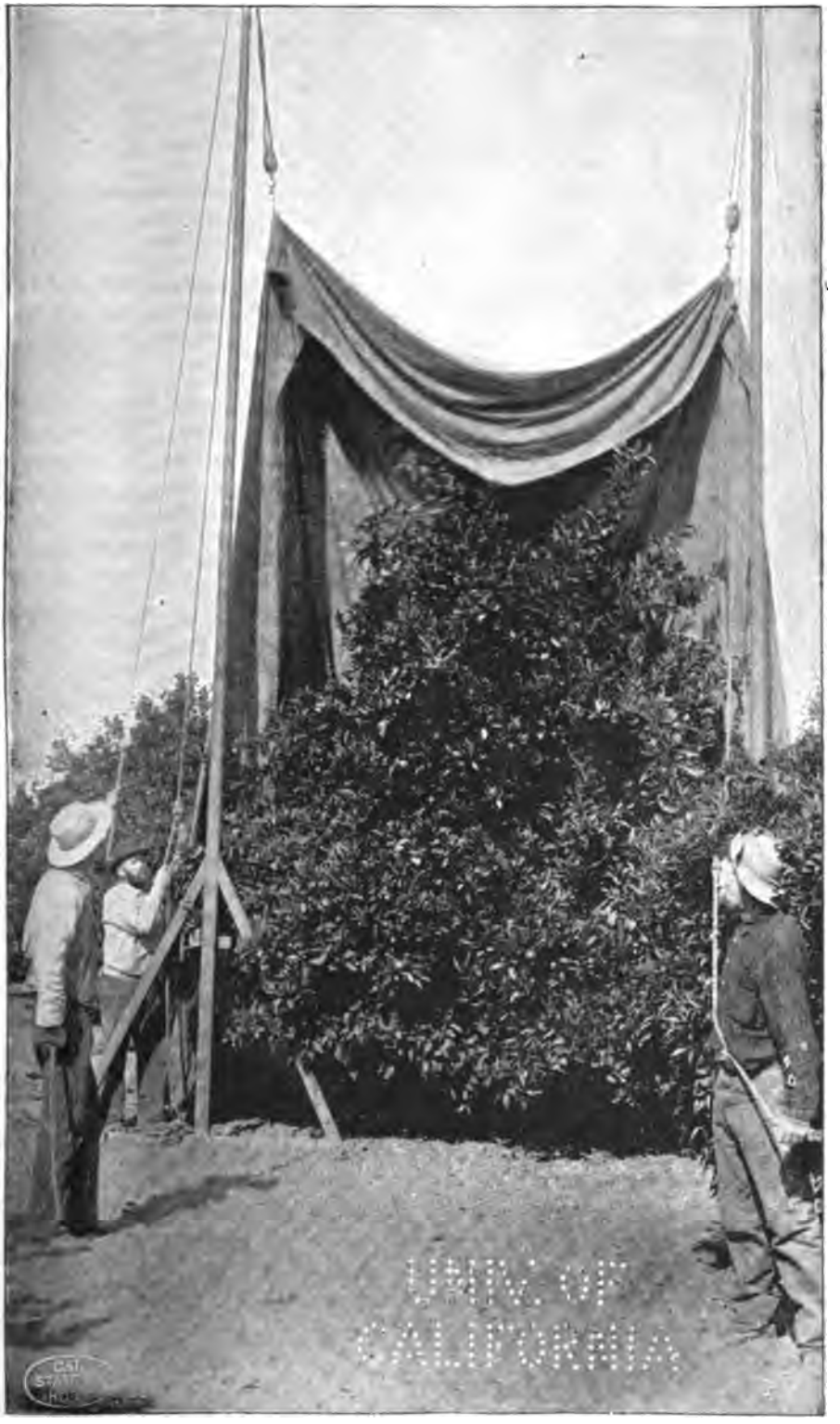
Hydrocyanic Acid Gas.—Fumigation with hydrocyanic acid gas is applicable for the destruction of scale insects on citrus trees, and to a slight extent on other trees. It is without doubt the most efficient remedy for this purpose yet brought into practical use. The eggs of the insects do not succumb to the gas unless this is used at much greater strength than what is necessary to destroy the insects themselves. One treatment suffices for the destruction of those species in which the young are produced alive. Successive treatments at the ordinary strength are necessary to destroy all stages of egg-laying species, but it is more advisable to give several treatments at this strength than a single one which would destroy the eggs, because of the liability of seriously injuring the trees in the latter case.

In general, the treatment consists in covering the trees with an air-tight cloth made in the form of a tent or sheet. The gas is then generated beneath this cover by acting on potassium cyanide with sulphuric acid, the amounts of the chemicals used depending upon the dimensions of the tree. The coverings are removed after the expiration of half or three-quarters of an hour, by which time the gas is largely

PLATE IV.

Blank

PLATE V.



SHEET USED FOR COVERING LARGE TREES IN FUMIGATING.

spent. Great care must be taken in the use of the gas as it is highly poisonous not only to insects, but also to the higher forms of life. When proper precautions are taken, however, there need be no more danger in its use than in the employment of arsenical sheep dips or strychnine for other farm purposes.

It is desirable to have various sizes of the coverings, and withal, the initial outfit demands an outlay so considerable that not every orchardist will find it economical to provide himself with an equipment for his sole use. But by co-operation among a number of growers, the expense per tree treated may be lowered to a figure which leaves a handsome margin of profit in the benefits which accrue from the operation. After the first expense for the equipment the chief item of cost is the labour, but this expense is not much if any greater than the expense of spraying citrus trees. When purchased in large quantities, the chemicals are not expensive. The cyanide may be procured in London at 10d. per pound in 224 pound lots, and the sulphuric acid in Cape Town for 50s. per case of 168 pounds; one merchant sells the acid at 26s. per case of 122 lbs. Estimating the cyanide to cost 1s. 6d. per lb. and the sulphuric acid 4d., the expense of the chemicals necessary for a tree ten feet in height would be about 3d.

During the past six months, several thousand trees have been fumigated by agents of the Horticultural Board in Wellington, Paarl, and Stellenbosch. It is expected that a report on this work will soon be submitted and published through the Department of Agriculture. Details of the equipment will be furnished, and also a table of the quantities of the chemicals required for different sizes of trees. Parties desirous of enquiring into this means of destroying scale insects will do well to procure a copy of this report when it appears.

Resin Wash.—The standard formula for resin wash is:—

Resin	24 lbs.
Caustic Soda (98 per cent.)	5 lbs.
Fish-oil	3 pints ($2\frac{1}{4}$ bottles).

With water to make 100 gallons of diluted wash.

As 100 gallons is a larger quantity than many would care to prepare, the proportionate amounts of the ingredients for smaller quantities are given.

For dilute wash containing—

	50 galls.	25 galls.	10 galls.
Resin ...	12 lbs.	6 lbs.	$2\frac{1}{2}$ lbs.
Caustic Soda	$2\frac{1}{2}$ lbs.	$1\frac{1}{4}$ lbs.	$\frac{1}{2}$ lb.
Fish-oil ...	$1\frac{1}{4}$ bottles	$\frac{1}{2}$ bottle	$\frac{1}{4}$ bottle.

First crush the resin, which may be easily done by placing it in a meal sack and pounding it. Pour at least two-thirds of a gallon of water into the cooking vessel for every pound of resin to be used, add the caustic soda and the oil and bring these to a boil. Then stir in the resin and keep this mixture well stirred while the resin dissolves. If the liquid boils over add a small quantity of cold water, but never much. The mixture at first is milky, but when the resin dissolves it becomes clear and dark brown, not unlike strong coffee. The boiling need not be continued over ten minutes when this stage is reached, and then water to bring the total quantity of the liquid above 21 gallons (when full quantity is made) should be added. The making of the wash is then complete.

It will be found an advantage to mark on the cooking vessel the exact height reached by the number of gallons to which the concentrated wash is diluted in the cooking. As stated, this should be above 21 gallons when the 100 gallon formula is used. The best height to mark and fill up to is that reached by 25 gallons; or if the quantities of the ingredients which have been taken are for 50 gallons of dilute wash, or 25, or 10, the proportionate parts of 25, that is, $12\frac{1}{2}$, $6\frac{1}{4}$, and $2\frac{1}{2}$, respectively. Then for use, one measure of this concentrated wash may be taken for each three of clear water, thus obtaining the proper dilution without the trouble of measuring by the gallon.

Of course, if it is more convenient, the full amount of water may be added at once; but it is generally more desirable to make a concentrated wash, and then to dilute this as it is used. When properly made, the concentrated wash should keep without settling in a covered vessel. If

left in an open vessel, it is apt to settle through part of its water being lost by evaporation; but if the amount lost is replaced and the wash heated until the sediment disappears, the wash seems as good as when freshly prepared.

Resin wash answers best when applied hot. Therefore, it is best to always heat the water with which it is diluted. The spray, as it strikes the foliage, should not be above 130 degrees Fahrenheit, but unless the spray is very coarse, or the nozzle held very close to the tree, the wash becomes cooled to below this temperature before it strikes the tree, even when it is scalding hot in the spray-tank. There is no danger of injuring the tree by the heat when the hose through which the liquid passes can be held in the uncovered hand.

A wash made without the fish-oil, though not so effectual as one prepared according to the formula, is still a good insecticide, and is recommended for use when fish-oil is unobtainable. It will be completely effectual for the Brown or Soft Scale, and for aphides, as well as for the young of other scale insects, but when applied against adult Red Scale, its action will be found less perfect than that of the normal resin wash. The substitution of soft-soap for the fish-oil when this is difficult to obtain is recommended by some Californian parties. One and one-half pounds of the soap are used to substitute each pint of oil. I have not made comparative tests with the resulting wash, but have found it a good scale destroyer on several occasions, and would recommend it in preference to a wash containing only the resin and caustic soda.

Resin can be purchased in Cape Town at 12s. per hundred pounds; or at the rate of 7s. 6d. per hundred pounds if a full barrel of 240 pounds is taken. In smaller quantities it sells at 3d. per pound. It is best to buy the caustic soda in small tins; a one-pound tin costs 9d., and larger tins slightly less in comparison. Fish-oil by the gallon generally retails at 4s. 6d. It will probably be somewhat cheaper when the tariff is reduced as it sells in London, a dealer tells me, at about 1s. 4d. By "fish-oil" is meant any fish or whale oil.

Lime-Sulphur-Salt Wash.—Lime-sulphur-salt wash is a

disagreeable wash to prepare and to handle, but for many purposes it is an excellent tree-wash. It is really a lime and sulphur sheep dip with salt added to cause it to adhere to the trees. The most popular formula is:—

Unslaked Lime	40 lbs.
Sulphur	20 lbs.
Stock Salt	15 lbs.

With water to make 50 gallons.

Place 10 pounds of lime and 20 pounds of sulphur in the cooking kettle with 15 gallons of water. Boil until the sulphur is thoroughly dissolved, which will take about one and one-half hours. Slake the remaining 30 pounds of lime in water and stir in the salt; and when these have mixed like whitewash, add them to the lime and sulphur mixture. Stir thoroughly or cook awhile longer and add water to make the full quantity of 50 gallons. Strain through a cloth or fine sieve to remove coarse particles and sand. Before adding the sulpher to the lime, it is well to stir it to an even paste with a small quantity of water.

This should be warm when applied to the trees, and should be kept stirred. It must never be applied to trees while they are in leaf. Also, avoid cooking in a copper vessel, as the sulphur will combine with the metal and thus injure it. The wash is likewise detrimental to copper spray tanks, especially if it is very hot. It is best to cook it in an iron pot and to spray from a wooden vessel. Unslaked lime is much superior to ordinary lime for making the wash, and can be procured of the lime-burners if ordered a short time in advance of when needed.

Because of its gritty nature, the wash is wearing to the spraying apparatus. In California, a special nozzle with rubber parts at the orifice is sold for use with it; the rubber may be cheaply replaced when worn. Some of these nozzles will probably be soon procurable in the colony.

Soda and Sulphur Wash.—Mr. H. G. Webber, one of the staff of the United States Division of Vegetable Pathology, has sent me the following directions for preparing this com-

pound. Place 30 pounds of flowers of sulphur in a barrel, and stir to a stiff paste with about two and a-half gallons of water. Then add 20 pounds of 98 per cent. caustic soda (powdered) and stir well. The mass becomes hot in a few moments and turns brown, liquifies and boils. Keep stirred, and as soon as it no longer boils, strain off the clear brown liquid and dilute it to 16 gallons with water. This is a stock solution, and may be kept for months if stored in a tight barrel and protected from air.

It is very essential to have a large vessel, as the mixture becomes very hot and boils up when the union of the soda and sulphur takes place. It is also very important not to have the flowers of sulphur too wet; the paste should be so stiff as to be difficult to stir, and should stick to the sides of the barrel.

One gallon of the stock solution is mixed with 50 to 200 gallons of water for use against different species of mites affecting citrus trees in Florida. One gallon to 50 gallons of water would probably be the proper proportion for use against the Red Spider and Bryobia Mite on foliage.

Paraffine Emulsion.—Paraffine* is a powerful contact insecticide, but most plants are injured by it when it is applied undiluted. Fortunately it retains its insecticidal properties even when diluted to a considerable extent. It is lighter than water, and quickly separates when mixed with it. Within the last few years, spraying apparatus has been devised which makes a mechanical mixture of paraffine and water in the required proportions by the act of pumping. The apparatus is not, however, sufficiently perfected to recommend its use among beginners in spraying. To obtain satisfactory results with diluted oil, it is necessary to first emulsify it with soap or milk.

The most approved formula for preparing an emulsion of paraffine with soap is the one known as the Riley-Hubbard, which is:—

Hard Soap	...	...	$1\frac{1}{4}$ pounds,
Paraffine	...	...	4 gallons (1 tin),
Water	...	...	2 gallons.

* "Paraffine" in Cape Colony is the popular term for the refined petroleum illuminating oils imported from America.

¶ Cut the soap into small pieces and boil until dissolved in the water. Add the boiling solution to the paraffine, and at once churn the mixture, and keep it violently agitated for ten minutes; five minutes may suffice if a small force pump is used to pump the liquid quickly back and forth. When it can be done without danger of the oil taking fire, it is well to heat the oil beforehand, or to keep the mixture over the heat while it is being agitated. A uniform, milky emulsion is thus produced, which becomes semi-solid on cooling. When properly made the emulsion will keep for a long time. It is diluted with water for use as recommended in the text; nine parts of water to one of emulsion is most frequently stated. The water and the emulsion must be thoroughly mixed. Soft water should be used both in preparing the emulsion and for diluting it.

With milk an emulsion may be prepared without heat, and with hard or soft water, but unless kept in a tight receptacle such an emulsion will ferment. A good formula is:—

Paraffine	2 gallons,
Milk	1 gallon.

Sour milk is preferable as the emulsion forms more quickly. Mix and churn the two ingredients until a thick butter-like consistency is obtained.

Condensed milk may be substituted for new milk, using the contents of five tins mixed with four bottles of water in the place of the gallon of milk in the above formula.*

General Remarks.—Insecticides applied to destroy scale insects, plant lice and allied insects should be in the form of a forcible spray. The insecticide should be finely divided as it strikes the plant, but not in the "cloud-like mist" so desirable in applying arsenical poisons.

"Contact" insecticides destroy insects by acting on the breathing organs, which, externally, are minute openings along the sides of the body. The insecticide may pene-

* The "bottle" is a recognised measure in the colony. It is equivalent to one-sixth of an imperial gallon. The proportions given in this formula are adopted from Lodeman's "Spraying Crops."

trate the body through these organs or, in the case of armoured scale insects when sprayed with resin wash, may seal the insect within its scale. The eggs of scale insects are sometimes destroyed by becoming coated with the insecticide so effectually that the hatching larva cannot escape. Contact insecticides, especially those containing soap or resin, are more effective when applied hot than when applied cool. Soapy and resinous washes are more fluid when hot and, therefore, spread much better and penetrate minute crevices which cooler and consequently thicker washes cannot enter.

These washes necessarily have some injurious action on the foliage as they form a film over the surface; but the injury is usually very slight in comparison with the benefits of the application and so is disregarded. When the season for spraying may be chosen, the injury may be altogether obviated in the case of deciduous trees by spraying during the winter months.

Citrus trees may be sprayed at any time of the year, but the period when least fruit is on the trees is to be preferred. The reason for the preference is that scale insects on the fruit are more difficult to destroy than those on other parts of the tree. Disregarding the fruit, the best season is probably March and April.

Adult scale insects are seldom immediately killed by the insecticides. Resin wash particularly requires several days to do its work, so a rain following shortly after the application will vitiate the results. Therefore the spraying against scale insects had best be done immediately after a rain when the probabilities are for several days of clear weather.

The recommendations for remedies made in the text except when otherwise specified have been made with reference to fruit trees. If it is desired to apply them to other plants, the effects of the insecticide on the plants should be experimentally ascertained beforehand to avoid danger of grevious results.

In spraying deciduous trees during the winter, there is a tendency even among careful sprayers to slight the tips of the branches; on this account, it is better to spray the trees before pruning them than afterward.

SELECTION OF SPRAY PUMPS.

Introductory.

The demand for spray pumps is rapidly increasing in the colony, and the time is no longer when the farmer is limited to a single style of pump with the alternative of specially importing another kind should that not suit his fancy or requirements. Eighteen months ago, the only spray pumps which I know to have been regularly stocked were the "Vermorel" knapsack and the Nixon Company's "Climax" pumps, the former by a few merchants in the cities and the latter by a single party at Graaff-Reinet. Under these conditions, it was an easy matter to choose a pump; but with the rapidly increasing demand, a greater number of merchants are interesting themselves in the trade, and naturally this has tended toward the introduction of many different makes and styles of pumps. Now, instead of a single make of knapsack pump, as many as a dozen have been placed on sale; and pumps for mounting on barrels from several manufacturers are offered.

This multiplicity in designs adds much to the difficulty of selecting a pump. Previously, when only one or two makes were obtainable, it was perfectly proper for the Government to openly recommend those particular pumps; but under the present conditions, it would be unfair for it to reserve its recommendation to any special make or makes. But it is just to discuss the features which are desirable in a pump and to indicate what designs of pumps are suitable under different circumstances.

First, it is well to point out that pumps for the application of insecticides and fungicides are very modern appliances. It was not much over fifteen years ago that American manufacturers, who supply most of the pumps sold in the colony, first gave special attention to the construction of pumps for this purpose; and knapsack pumps, which are now so common, were scarcely known at all ten years ago. During this short period of spray pump construction, much progress has been made; and, moreover, improvements are still being constantly added. This being

the case, the pumps considered the best one year may be entirely outclassed during the next. Hence, it follows that we must judge the comparative worth of pumps by the actual merits they are seen to possess, and not by the testimonials concerning them; unless, indeed, these be of very recent date and of unquestionable authority.

Materials used in construction.

A spray pump to do the best service must be made of materials that will not be injuriously affected by the liquids to be used with it. Iron is so quickly corroded by many of the common insecticides and fungicides that pumps in which the working parts are of this metal are not desirable. These parts of the pump should always be made of hard brass. For the sake of economy, the bodies of most pumps are made of iron, but even here, the use of brass lends greater durability and is an advantage which in the end will probably pay for the additional initial cost. Rod-like parts and slim handles of cast iron are objectionable because so easily fractured.

Fig. 31.—Vermorel knapsack spray pump.

Any parts of rubber are damaged by contract with paraffine. Ignorance of this fact has led to the ruin of a large number of Vermorel knapsack pumps, in which a

circular rubber disc is used for the propulsion of the liquid. The paraffine causes the rubber to swell and thus become useless for its purpose.

Copper is the best metal for the tanks in knapsack pumps, and attention should be paid to the thickness of this metal. Thin copper will rapidly wear through. Tanks of sheet iron or tin are soon ruined by contact with liquids containing copper compounds such as Bordeaux mixture and Paris green, and these preparations are also injuriously affected. But even copper tanks are not suitable for use with all spraying mixtures, since this metal is acted upon by the sulphur in such compounds as "eau grison" and lime-sulphur-salt mixture. In these cases, the sulphur leaves the lime with which it had united during the process of cooking and unites with the copper to form copper sulphide. This compound forms in a thin, black layer over the copper, which if it would remain intact would preserve the metal from further action; but, unfortunately, some of it usually breaks away, exposing fresh surface to the injurious action and also proving an annoyance by passing through the hose and clogging the nozzle. For these reasons, it is best not to use these sulphur mixtures in knapsack pumps.

Form of Pump.

The form of the pump is an important consideration, simplicity and compactness being very desirable features. The nature of the work for which spray pumps are used renders it necessary that they should be able to withstand more or less abuse as well as use. Pumps with thin-necked air-chambers are apt to be soon seriously inpaired by an accidental blow, and a very tall pump may make the barrel or other receptacle upon which it is placed dangerously top-heavy as the liquid in the vessel nears exhaustion. Many pumps are made bulky and cumbersome by the use of a large air-chamber, this feature being added to secure a uniform and strong flow of liquid. But experience with different designs of spray pumps has shown that a large air vessel not only adds needless weight and bulk, but is directly a disadvantage by keeping up the flow of liquid for a long time after the pumping has ceased; it does not

Fig. 32.—Notus knapsack spray pump. (Loaned by Koch and Dixie, Cape Town.)

increase the pressure given by the pump. An air-chamber of sufficient capacity to keep up a uniform flow of the liquid through the one or more leads of hose fitted with the coarsest nozzles intended for use with the pump is all that is desirable. The size of an air-chamber required to secure such a flow varies to some extent with different models of pumps, a much larger one, naturally, being required for a single-action pump than for a double-action one.

Desirable Features in Knapsack Pumps.

Perfection in knapsack pumps has not yet been reached. The features desired are that the pumps should throw a constant and forcible stream of water, and have simple, durable working parts that can be easily removed for the making of repairs, and so placed as to be protected by the tank from the numerous accidental knocks which this form of pump is sure to receive at the hands of labourers in placing it on and removing it from the back; a simple agitator should be provided to ensure an equal distribution of liquids containing solids in suspension, and the tank should be of thick copper. A pump answering all of these

requirements has not yet been offered, but all of the features are exemplified in one or another of the pumps to be purchased. Much stress should be laid upon the working parts being removable with little trouble, as with some of the common washes, such for instance as resin wash, failure to properly clean the pump after use is generally followed by its failing to work at the next attempt to use it. Repair shops are few and far between in the colony, so it is highly desirable that the farmer be able to remove and clean the pump himself. The movement of the body in carrying the pump, no matter how much the carrier may "shake himself," is wholly inadequate to keep liquids in the tank properly agitated, and hand-stirring after the tank has been placed on the back is very awkward.

A Desirable Pattern.—The knapsack pump which has met with greatest favour in this country is the "Galloway." As ordinarily sold, this pump is not provided with an agitator, and if this accessory is wanted, a pump with one attached should be ordered. Most of the merchants who keep the pump in stock now sell the form with this

Fig. 33.—Galloway knapsack spray pump. (Loaned by G. Fitzday & Co., Cape Town.)

attachment, but when the pumps were first introduced, none were so fitted. There would be some trouble in adding the agitator to old pumps, but there is nothing to prevent its being done. The agitator has a vertical movement conforming to the motion of the piston rod, and though far from a perfect agitator, it is much better than none at all and is probably as good as any which could readily be fitted to this design of pump.

An Undesirable Pattern.—The form of knapsack pump in which the pump is not directly attached to the tank but is carried in the hands of the operator and worked in the manner of the old-fashioned "fountain pump," one hand holding the piston while the other draws out the piston rod, possesses so many disadvantages that it is inadvisable to invest in them even if they are offered at much less than what is asked for the pump above mentioned. Several merchants have offered them under the mistaken impression that they are as satisfactory as the other form.

Nozzles.

Designs of nozzles for spraying purposes are as numerous as the designs of spray pumps, each spray pump manufacturer generally supplying with his pumps nozzles of his own manufacture. The best form to use varies with the liquid to be applied, and, also, to some extent, with the height of the trees to be treated and the power of the pump used. The general rule should be to use the nozzle which will effect the desired end most quickly and with the least waste of liquid.

Fungicides and poisonous insecticides applied to the foliage should be in the form of a very fine spray; but an insecticide to destroy scale insects is most efficacious when applied in a coarser spray which strikes hard; such a coarse, penetrating spray being particularly necessary in spraying into the thick foliage of citrus trees, the wetting of the inner portions of which depends in part upon rebounded liquid or on that which drips from above. Even deciduous trees when leafless in winter, if badly infested

with scale insects, cannot be satisfactorily treated with a very fine spray.

The spray from a nozzle may be too heavy and coarse for good work at close quarters, but answer the purpose admirably at a greater range; and a powerful pump will make a mist-like spray out of a stream which a weaker pump would simply convert into great drops through the same nozzle.

Adjustable Patterns.—To meet varied requirements, manufacturers now furnish adjustable nozzles for all-round use. The name given to them varies with the manufacfacturer, but the principle is the same in most of those now offered in the colony. There is an external orifice to the nozzle closed by a stop-cock which is pierced by a small aperture for the passage of the liquid. The stop-cock may be turned to admit a free passage or so as to entirely check the flow; or turned just far enough to allow the liquid to pass, but in passing to strike the side of the orifice obliquely, and thus be broken into a fan-shaped spray of varying fineness according to the size of the stream allowed

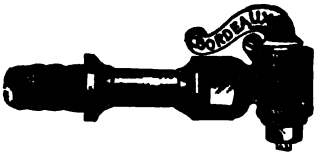


Fig. 34.—Bordeaux nozzle.

to pass and the angle at which this strikes the side of the outer orifice. These nozzles seldom clog, and when they do they may generally be quickly cleared by turning the stop-cock so as to allow an unimpeded passage of the liquid. The "Bordeaux," the "Seneca," and the "Masson" are nozzles of this pattern sold in Cape Town. The "McGowen" nozzle, an adjustable one which possesses the advantage of being self-cleaning to a large extent, is constructed on slightly different lines than those mentioned, and is one which appears to be rapidly growing in favour in the United States. It is, undoubtedly, the best nozzle to be had for the man who has much spraying

to be done, especially if the trees are large, but it is not the nozzle to give to the "Cape boy" for a small amount of work; in such hands, its nice but somewhat complicated adjustment would not be appreciated. This may also be purchased in Cape Town.

The "Climax" Pattern.—The manufacturers of the "Climax" spray pumps meet the demand for varied sprays by furnishing a set of six nozzles, one throwing a very coarse spray, one a very fine mist, and the others intermediate degrees of subdivision. Two nozzles are generally sold with each pump. In these nozzles, a jet of the liquid strikes a wire gauze, against which it breaks into a spray which varies in character with the size of the meshes. Many of these nozzles are in use in the colony. They were classed as the best a few years ago, but their lack of adjustibility, and the difficulty of cleaning the meshes of the gauze when they become obstructed are disadvantages which are overcome in more recent designs of nozzles.

Vermorel Pattern.—While for general work adjustable stop-cock nozzles are most advantageous, "Cyclone" nozzles, of which the "Vermorel" may be taken as the type, are far superior when a very fine mist-spray is desired. The liquid in these nozzles is forced to whirl with great

Fig. 35.—Deming Co.'s "Vermorel" nozzle.

rapidity in a circular chamber before passing through the small, round outlet. This whirling motion causes the liquid to break into exceedingly fine particles as it leaves the vent. The spray thus produced spreads outwardly in a circular form, not flat and fan-shaped as from stop-cock nozzles; when the vent is very small this spray may be so finely divided that it floats in the air.

The best of the cyclone nozzles are provided with a pin attachment, which may be pushed forward into the vent

to dislodge an obstruction. Another useful feature in some makes is the addition of a swivel joint by the use of which the vent may be directed straight forward or up or down. The feature is a great convenience when it is necessary to spray the lower surface of the foliage of bushes or vines. A slight range of adjustment is obtained in cyclone nozzles by the use of caps containing vents of different diameters. The nozzles usually furnished with knapsack pumps are of this pattern.

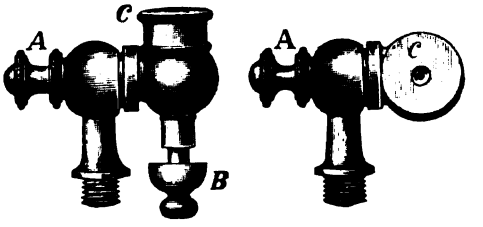


Fig. 36.—Vermorel Swivel nozzle. *a*, swivel; *b*, pin for cleaning vent; *c*, cap with vent.

As the cyclone nozzles are superior for some work to the adjustable stop-cock nozzles but inferior to them for other work, it is advisable to have both forms, and to use the one or the other according to the requirements of the work, the cyclone form for "mist" spraying, and the other when a coarser spray is wanted, or when the spray must be thrown to a distance.

Lime-sulphur-salt wash is wearing to nozzles owing to its gritty nature. In California, a special nozzle is sold for use with this wash; the wear in this is mostly to a rubber disc, which can be easily replaced. Some of these nozzles will probably be soon sold in the colony.

Styles of Pumps.

Spray pumps are made in different sizes and styles to adapt them to varied circumstances and uses. For the present purpose we will class the many styles in five groups, viz.:—1, Hand Syringes; 2, Bucket Pumps; 3, Knapsack Pumps; 4, Barrel Pumps; 5, Geared Machinery.

Hand Syringes.—By "hand syringes" is meant all pumps in which the liquid is discharged through the orifice by which it is taken up. Such appliances do very slow work, and, as a rule, waste a large amount of liquid. Small pumps which will perform all the work which they are capable of, and do it more quickly and in a more satisfactory manner may now be purchased almost as cheaply; so, as a spray pump, the hand-syringe is an out-of-date contrivance.

Bucket Pumps.—The second class consists of the appliances suitable for pumping from a bucket or other small vessel, and discharging through a different orifice than the one at which the liquid enters. There are a number of forms. Those throwing an intermittent stream should be avoided, and neither can I recommend those in which the pump proper is designed to rest on the ground and to receive the liquid through a hose extending into the bucket. The hose too frequently becomes accidentally thrown out of the bucket on to the ground, where, being moist, it picks up soil and dirt which works into the pump and nozzle and causes much annoyance. In the best form, the pump stands in the bucket, and is provided with a foot-rest projecting from the cylinder and reaching to the ground. This form has met with an excellent sale during

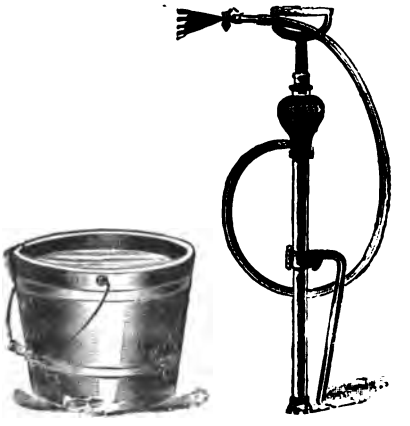


Fig. 37.—Deming Co.'s "Success" bucket pump. (Loaned by G. Findlay & Co., Cape Town.)

the past year in and about Cape Town; the principal use to which it is here put is the application of Paris green to pear trees in small gardens for the destruction of the Pear Slug. Forms in which the foot is designed to rest on a support projecting from the cylinder, but over the liquid, are not so desirable. Soil from the boot falls into the bucket and interferes with the proper working of the pump.

Knapsack Pumps.—Knapsack pumps possess many features to recommend them for general use. They are best adapted for work among young trees and bushes, which is, generally, where there is a large amount of ground to cover with little spraying. In vineyards, also, they are very useful, as these places are inaccessible to wheeled vehicles when the vines are planted and trained as is the custom in the colony. But knapsack pumps are not the proper appliances where much liquid is to be applied from one position or where there is a large amount of work which could be done with a larger pump, pumping from a vessel which requires less frequent refilling. A more suitable barrel pump could be purchased for the same outlay. The desirable features of knapsack pumps have been discussed. Different makes are of different sizes, and this should be considered in purchasing. One holding but two or three gallons, though the best, perhaps, for a small home-garden, requires too frequent filling for orchard or vineyard use.

Barrel Pumps.—Barrel pumps are large sized pumps suitable for pumping from a barrel or tank. They are chiefly intended for orchard use, and should be employed at the Cape in many instances where knapsack pumps are made to answer. Several desirable makes are now stocked in Cape Town and are sold at reasonable prices. In general, it is necessary to place the barrel or tank on a wagon or cart and to employ horse-power to move it about; but in many cases, especially in small orchards not easily accessible by a cart, man-power may be satisfactorily substituted. It is best, then, to use a medium sized pump, say one with a $1\frac{1}{2}$ inch cyclinder, and to mount it on a cask of between

Fig. 550.

Fig. 38.—Deming Co.'s "No. 550" spray pump. (Loaned by G. Findlay & Co., Cape Town.)

12 and 18 gallons capacity which two men can carry by means of long handles passing under broad, flat hooks or trunnions secured slightly above the middle of the cask. A pump thus mounted and carried is in use for the Board of Horticulture. The expense of such an outfit need be no more than that of a knapsack pump; a good pump for the purpose may be had for 27s., and the next largest item is the cask. Two men can operate the outfit without trouble, one spraying while the other pumps.

When horse-power is used, a larger size of pump is more economical. Two lines of hose should then be attached and three men employed, one for driving the horse and pumping and the others for spraying. When carried on a wagon or cart, it is considered best to have the barrel on its side as in this position the contents are more easily agitated and there is less chance of an upset. Some of the best pumps, however, cannot be used in this position.

"Barrel carts" may be purchased in Cape Town of one or two dealers; they are simply wheels attached to a light frame work in which the barrel is supported on trunnions.

These are imported from America, and being bulky, the freight bill is large; consequently, their cost prevents a ready sale. The manufacturers of the Climax pumps send out a complete spraying outfit consisting of a well-made tank permanently mounted on wheels and provided with spray pump, hose, nozzles, agitator, and all other requirements. If these are purchased for orchard use, the wheels should have broad tires or difficulty will be experienced in dragging them over cultivated soil.

Fig. 39.—Nixon's Co.'s "Climax" spray pump. (Loaned by Wm. Roe, Graaff-Reinet.)

Automatic agitators are not a necessity with barrel or bucket pumps. Their action must be supplemented by more or less hand stirring. They depend for their motion upon the movement of the piston-rod, and the liquid settles when the action of pumping ceases. Most of them have the fault of moving the liquid in set currents, and thus allowing solids in suspension to become deposited outside of these spheres of motion. Whether they are used or not, a paddle of some kind should be kept with the pump and used frequently to thoroughly agitate the liquid. Some spray pump manufacturers recommend a return stream of the liquid to agitate the contents of the tank, but this measure is also open to the same objection of establishing set currents in the liquid, and, moreover, it is applied at the expense of greater power than direct hand stirring.

The discharge hose generally supplied with barrel pumps is too short for work at good advantage. Twenty feet, at least, should be used, so as to be able to spray the trees on both sides when the outfit is drawn between rows.

A rod of some kind to elevate the nozzle is very desirable with barrel and bucket, and, also, knapsack pumps. For the small pumps, a one-half inch brass rod about four feet in length answers very well, but for the large sizes of pumps, a bamboo rod lined with brass tube, and eight to ten feet in length is more convenient. These are prepared by some of the manufacturers and sent out for use with their pumps.

Geared Machinery.—This group of spraying appliances is made of pumps worked by power derived from the revolving wheels of the vehicle bearing the spray tank. Such pumps do not prove much of a success for the spraying of orchards except when the trees are small. For the spraying of potatoes and other field crops, nursery stock and trellised vineyards, they are, however, preferable to hand-power pumps when much work is to be done. I do not know of any at present in the colony, but I am informed that a few have been imported and sent to Natal. They are not complicated contrivances, and a farmer of fair mechanical ability could easily fit one up for himself.

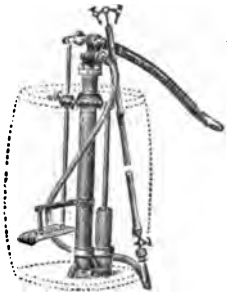


Fig. 40.—Morrill & Morley's "Eclipse" spray pump. One of the most recent designs, and one highly recommended. (Loaned by J. Robertson & Co., Cape Town.)

Steam and gas engines are used to a limited extent in the United States to supply the pumping power where high

trees are to be sprayed in large numbers, but no one that I know of in South Africa has sufficient spraying to be done to warrant using an engine even if one is available unless, perchance, the present prices of fuel take a huge tumble.

Gravity spraying appliances, that is, spraying apparatus in which the force of gravity is used to propel the liquid, are of very little value for applying insecticides and fungicides. They are, of course, only adaptable for low growing plants. The pressure given to the liquid is ever-varying and a much larger amount of liquid is required to wet a given area than if this was applied with greater force.

Care of Spray Pumps.

Before a spray pump of any kind is put away after use, it should be thoroughly washed and clear water pumped through it; hot water answers much better than cold if sticky or soapy washes have been used. The working parts should be occasionally oiled; and if the paint on the iron parts becomes worn away, it should be renewed. Attention to these details will preserve the pump for a long period, while if they are neglected, the pump may never save its initial cost.

Further Information.

In concluding this chapter on spray pumps, I would like to make it known to the farmers of the colony that they are cordially invited to write at any time to this office for more complete information. It is my endeavour to keep in touch with the merchants importing spray pumps, so it is generally known to me where any particular spray pump may be obtained.

Summary.

The working-parts of spray pumps should be of hard brass.

The use of rubber in a spray pump is objectionable as it is injured by preparations containing paraffine.

The tank of a knapsack pump should be of good copper. Sheet iron or tin tanks soon wear out because of the chemical action of many spraying liquids.

Copper tanks are injured by lime-sulphur-salt wash and by other liquids containing sulphur in a dissolved form.

Compactness and simplicity are qualities which should be demanded.

A knapsack pump should throw a constant stream and have removable working-parts; also an agitator if any of the spraying liquids to be used require stirring. The forms of knapsack pumps in which the working-parts are designed to be carried in the hands of the operator are unsatisfactory.

Adjustable nozzles are best for coarse spraying, and cyclone nozzles are best when a very fine spray is wanted. It is advisable to be provided with both kinds.

Bucket pumps answer well for garden use. The pump should stand in the bucket and the foot-rest should extend down and rest on the ground.

Knapsack pumps are excellent for spraying large orchards of small trees, bushes, and vines, and for use in places inaccessible to wheel-mounted contrivances.

Barrel pumps should be used for general orchard spraying. A small one, mounted on a small cask and carried by two men will answer for a small orchard; but for a large orchard, a large pump mounted on a full-sized barrel and drawn by horse-power is more economical.

Automatic agitators for any but knapsack pumps are a convenience, not a necessity. Return water agitators are of little value.

Pumps worked by power derived from the wheels are successful for spraying low-growing crops, young orchards and trellised vines.

Never fail to wash out the pump with clear water after using it.

PLANT INDEX.

A.

Aberia caffra, see Kei Apple.
Abutilon, Brown Scale on, 84.
Acacia, Greedy Scale on, 64.
  decurrens, see Black Wattle.
  horrida, see Thorn Tree.
  melanoxylon, see Blackwood.
  saligna, see Port Jackson Willow.
Agave americana, see American Aloe.
Almond, Black Scale on, 89.
  Bryobia Mite on, 124.
  Greedy Scale on, 64.
American Aloe, Oleander Scale on, 59, 61.
  Red Scale on, 50.
Apple, Black Scale on, 89.
  Blight-proof varieties, 111.
  Bryobia Mite on, 124.
  Greedy Scale on, 64, 65.
  maggot in fruit of, 10.
  Oyster Shell Bark Louse on, 25, 75.
  Red Scale on, 50, 52.
  stain produced by Red Scale, 52.
  Woolly Aphis on, 108.
Apricot, attacked by Codlin Moth, 10.
  Black Scale on, 89.
  maggot in fruit of, 10.
  Oyster Shell Bark Louse on, 75.
  Red Scale on, 50.
  White Peach-Scale on, 78.
Arbor-vitæ, Oleander Scale on, 60.
Ash, Oyster Shell Bark Louse on, 75.

B.

Bay, Brown Scale on, 84.
  Sweet, Red Scale on, 50.
Beans, Red Spider on, 120.
Bel Sombra, Oleander Scale on, 59.
  Red Scale on, 50, 53.
Birch, Greedy Scale on, 64.
  Oyster Shell Bark Louse, 75.
Blackberry, maggot in fruit of, 10.
Black Wattle, Oleander Scale on, 59, 61.
Blackwood, Australian Bug on, 93.
  Brown Scale on, 84.
  Red Scale on, 50, 53.
Blue Gum, Blue Gum Louse on, 115,
  Greedy Scale on, 64, 65.
Buckthorn, Oyster Shell Bark Louse, 75.

C.

Cabbage, Cabbage Aphis on, 104.
California Walnut, Greedy Scale on, 64.
Camellia, Brown Scale on, 84.
  Greedy Scale on, 64.
Cape Gooseberry, Black Scale on, 88.
  Oleander Scale on, 60.
  Red Spider on, 120.
  White Peach-Scale on, 78.
Capsicum, White Peach-Scale on, 78.
Carnation, Oleander Scale on, 60, 61.
Carob, Red Scale on, 50, 53.
Ceratonia siliqua, see Carob.
Cherry, Oleander Scale on, 60.
  White Peach-Scale on, 78.
  Wild Red, Oyster Shell Bark Louse on, 75.
Chestnut, Horse, Oyster Shell Bark Louse on, 75.
Cinchona, Greedy Scale on, 65.
Citrus trees, see also Orange, Lemon, etc.
  Australian Bug on, 93.
  Black Scale on, 88.
  Brown Scale on, 84.
  Citrus Psylla on, 116.
  Long Scale on, 71.
  Orange Aphis on, 104.
  Purple Scale on, 69.
  Red Scale on, 50.
  scale insects on imported, 24, 25.
  when to spray, 137.
Clover, Bryobia Mite on, 125.
Cotton, White Peach-Scale on, 78.
Cottonwood, Greedy Scale on, 64.
  Oyster Shell Bark Louse on, 75.
Cucumber, maggot in fruit of, 10.
Cupressus macrocarpa, see Cypress.
Currant, Oleander Scale on, 60.
  Oyster Shell Bark Louse on, 75.
Cypress, Red Scale on, 50, 54.

D.

Drei-doorn, Red Spider on, 121.
Dogwood, Oyster Shell Bark Louse on, 75.

E.

Elm, Oyster Shell Bark Louse on, 75.
  Red Scale on, 50, 54.

English Holly, Brown Scale on, 84.
Greedy Scale on, 64.
English Ivy, Oleander Scale on, 60.
English Myrtle, Greedy Scale on, 64.
English Walnut, Red Scale on, 50, 52.
Eucalyptus, Greedy Scale on, 64.
globosus, see Blue Gum.
Euonymous japonicus, Greedy Scale on, 64.

F.

Fig, Brown Scale on, 84.
Greedy Scale on, 64, 65.
Mealy Bug on, 99.
Oleander Scale on, 59, 61.
Oyster Shell Bark Louse on, 75.
Fuchsia, Greedy Scale on, 64.
White Peach-Scale on, 78.

G.

Geranium, White Peach-Scale on, 78.
Golden Feather, Greedy Scale on, 64.
Gooseberry, Cape, Black Scale on, 88.
Oleander Scale on, 60
Red Spider on, 120.
White Peach-Scale on, 78.
Granadilla, Black Scale on, 88.
Mealy Bug on, 99.
White Peach-Scale on, 78.
Grape, Bryobia Mite on, 125.
Calandra on, 7.
Greedy Scale on, 64.
Oyster Shell Bark Louse on, 75.
Red Scale on, 52.
White Peach-Scale on, 78.
Guava, Brown Scale on, 84.
Black Scale on, 89.
Greedy Scale on, 64.
maggot in fruit of, 10.
Mealy Bug on, 99.

H.

Hakea, Oleander Scale on, 59, 61.
Harpephyllum caffrum, see Kafir Plum.
Hawthorn, Oyster Shell Bark Louse on, 75.
Heath, Oyster Shell Bark Louse on, 75.
Holly, English, Brown Scale on, 84.
Greedy Scale on, 64.
Honeysuckle, Oleander Scale on, 59.
Oyster Shell Bark Louse on, 75.
Horse Chestnut, Oyster Shell Bark Louse on, 75.

I.

Ivy, English, Oleander Scale on, 60.

J.

Jessamine, Cape, Oleander Scale on, 59.
White, Black Scale on, 88.
Yellow, White Peach-Scale on, 78.

K.

Kafir Plum, maggot in fruit of, 10.
Oleander Scale on, 59.
Kei Apple, Lecanium on, 87.
Keur-boom, Red Scale on, 50, 54.

L.

Laurel, Greedy Scale on, 64.
Mountain, Greedy Scale on, 64.
Lemon, also see Citrus trees.
Citrus Psylla on, 116.
Greedy Scale on, 64, 66.
Mealy Bug on, 99.
Oleander Scale on, 59, 60.
Red Scale on, 50.
Lignum Vitae, Red Scale on, 49.
Lilac, Oleander Scale on, 60.
Oyster Shell Bark Louse on, 75.
Linden, Oyster Shell Bark Louse on, 75.
Locust, Greedy Scale on, 64.
Loquat, Greedy Scale on, 64.
maggot in fruit of, 10.

M.

Magnolia, Oleander Scale on, 60.
Maple, Greedy Scale on, 64.
Oleander Scale on, 60.
Oyster Shell Bark Louse, 75.
Medlar, Oyster Shell Bark Louse on, 75.
Melia azedarach, see Seringa.
Melon, maggot in fruit of, 10.
Red Spider on, 120, 121.
Morning Glory, White Peach-Scale on, 78.
Mountain Laurel, Greedy Scale on, 65.
Mulberry, Oleander Scale on, 59, 61.
Red Scale on, 50, 50, 52.
White Peach-Scale on, 78.
Murraya, Purple Scale on, 70.
Myoporum, Greedy Scale on, 64.
White Peach-Scale, 78.
Myrtle, English, Greedy Scale on, 64.

N.

Naartje, see also Citrus trees.
Citrus Psylla on, 116.
Red Scale on, 50.
Nectarine, maggot in fruit of, 10.

O.

Oak, Oleander Scale on, 60.
Red Scale on, 50, 53.
Oleander, Black Scale on, 88.
Oleander Scale on, 59, 61.
Olive, Black Scale on, 88, 89.
Greedy Scale on, 64.
Oleander Scale on, 60.
Red Scale on, 50, 52.

Orange, see also Citrus trees.
Black Scale on, 89.
Citrus Psylla on, 116.
Greedy Scale on, 64, 66.
maggot in fruit of, 10.
Mealy Bug on, 99.
Oleander Scale on, 60
Red Scale on, 50.

P.

Passiflora edulis, see Granadilla.
Peach, Bryobia Mite on, 124.
injured by resin wash, 83.
maggot in fruit of, 10.
Myzus persicæ on, 106.
Oyster Shell Bark Louse, 75.
White Peach-Scale on, 78.
Pear, attacked by Codlin Moth, 10.
Black Scale on, 89.
Bryobia Mite on, 124.
Greedy Scale on, 64, 65, 67.
maggot in fruit of. 10
Oyster Shell Bark Louse on, 75.
Pear Leaf Blister Mite on, 127.
Pear Psylla on, 116.
Red Scale on, 50, 52.
stain produced by Red Scale, 52.
White Peach-Scale on, 78.
Woolly Aphis on, 108.
Pepper Tree, Brown Scale on, 84.
Phyt lacca dioica, see Bel Sombra.
Plane Tree, Oyster Shell Bark Louse on, 75.
Plum, Black Scale on, 89.
Bryobia Mite on, 124.
Oleander Scale on, 59, 61.
Oyster Shell Bark Louse on, 75.
Red Spider on, 120.
White Peach-Scale on, 78.
Plumbago, Australian Bug on, 93.
Polygala myrtifolia, White Peach-Scale on, 78.
Poplar, Oyster Shell Bark Louse on, 75.
Port Jackson Willow, Oleander Scale on, 59, 61.
Privet, Red Scale on, 50, 53.
Prune, Bryobia Mite on, 124.

Q.

Quince, Black Scale on, 88.
Brown Scale on, 84.
Greedy Scale on, 64.
maggot in fruit of, 10.
Oyster Shell Bark Louse on, 75.

R.

Raspberry, Oyster Shell Bark Louse on, 75.
Rhamnus croceus, Greedy Scale on, 64.
Rose, Black Scale on, 89.
Brown Scale on, 84.
Red Scale on, 50, 52.
stain produced by Red Scale, 52.

S.

Seringa, Oleander Scale on, 59, 61.
Red Scale on, 50, 53.
Shaddock, see also Citrus trees.
Citrus Psylla on, 116.
Silver Tree, Greedy Scale on, 64, 65.
Spiræa, Oyster Shell Bark Louse, 75.
Sweet Bay, Red Scale on, 50, 53.

T.

Tea, Greedy Scale on, 65.
Thorn Tree, scale insects on, 42.

U.

Umbellularia californica, Greedy Scale on, 65.

V.

Veronica, Greedy Scale on, 64.
Vine, see Grape.
Virgilia capensis, see Keur-boom.

W.

Walnut, California, Greedy Scale on, 64.
English, Red Scale on, 50, 52.
Willow, Greedy Scale on, 64.
Oyster Shell Bark Louse on, 75.
Port Jackson, Oleander Scale on, 59.
Red Scale on, 50, 53.

Y.

Yucca, Oleander Scale on, 60.

GENERAL INDEX.

A

Acarina or Mites, 119.
Acridium peregrinum, not purpuriferum, 19, 20.
purpuriferum, notes on, 19-21.
ruficorne, in vineyards, 22.
Agitators for spray pumps, 142, 150.
American Blight, see Woolly Aphis.
Aphelinus diaspidis, parasite of Oleander Scale, 62.
Aphididæ or Plant Lice, article on, 102-107.
general character and habits of, 102.
how disseminated, 104.
influence of climate on, 104.
injuries inflicted by, 104.
mode of reproduction in, 103.
natural enemies of, 105.
remedies for, 106.
Aphycus sp., parasite of Black Scale, 91.
Apple Scale, see Oyster Shell Bark Louse.
Apple-Root Plant Louse, see Woolly Aphis.
Aspidiotophagus citrinus, parasite of White Peach-Scale, 81.
Aspidiotus aurantii, see Red Scale.
camelliæ, see Greedy Scale.
limonii, on European lemons, 60.
nerii, see Oleander Scale.
Australian Bug, article on 92-98.
description and habits of, 93.
distribution of, 93.
enemies of, 95.
food plants of, 93.
occurrence in Cape Colony of, 93.
remedies for, 97.
Australian lady-birds, introduced, 17.

B

Barrel pumps, utility of, 148.
Black Scale, also see Brown Scale, 83.
article on, 87-92.
description and habits of, 90.
distribution of, 88.
enemies of, 91.
food plants abroad, 88.
found on imported trees, 24.
occurrence and food plants of, 88.
remedies for, 92.
Blight-proof stocks for Woolly Aphis, 111.
Broad Scale, see Brown or Soft Scale, 83.
Blood Insect, see Woolly Aphis, 107.
Blue Gum Louse on Blue Gum, 115.
Brown or Soft Scale, article on, 83-87.
accompanied by smut, 85.
description and habits of, 84.
distribution of, 83.
enemies of, 86.
food plants of, 84.
found on imported trees, 24.
occurrence in Cape Colony of, 83.
remedies for, 87.
Bryobia Mite, article on, 123-126.
description and habits of, 125.
food plants of, 124.
injuries from, 125.
occurrence in Cape Colony of, 123.
remedies for, 126.
Bryobia pratensis, an American species, 123, 124, 125.
species, a European species, 123, 126.
Bucket pumps, utility of, 148.
Bug, use of term, 34.

C

Cabbage Aphis, figure of, 103.
Calandra of Vine, notes on, 7-9.
lime as remedy for, 8.
Carpocapsa pomonella, see Codlin Moth, 10.
Ceratatis capitata, see Peach Fly, 10.
Ceroplastes sp., found on imported trees, 24.
Chaff Scale, found on imported fruit, 25.
Chilomenes lunata, enemy of aphides, 105.
Chionaspis sp., found on imported trees, 24.
Chilocorus distigma, see Two Spotted Lady-bird, 80.
Citrus Psylla, article on, 116-118.
description and habits of, 117.
enemies and remedies, 118.
food plants of 116.
injuries caused by, 118.
Clover Mite, see Bryobia, 123-125.
Coast Locust, see Red-Winged Locust, 19.

Coccidæ or Scale Insects, article on, 35-48.
classification of, 35.
food habits of, 42.
how disseminated, 38.
influence of climate on, 42.
injuries inflicted by, 44.
life history of, 36.
natural enemies of, 45.
Coccinæ, general characters of, 35.
Codlin Moth, notes on, 10-11.
at Graaff-Reinet, 10.
at Stellenbosch, 10.
oviposition of, 11.
Cottony Cushion Scale, see Australian Bug.

D

Dactylopius sp., see Mealy Bug.
citri, on Citrus trees and fruit, 98, 99.
longispinus, figure of, 99.
Dacus ferrugineus, infesting cucurbs, 10.
Details of remedies, 130-137.
Diaspinæ, general characters of, 35.
Diaspis amygdali, see White Peach-Scale.
Dorthesia, see Australian Bug.

E

Egyptian Locust, see Red-Winged Locust, 19.
Empusa grylli, destroying locusts, 21.
Exochomus nigromaculata, see Shining Black Lady-bird.
Experiments with insecticides, notes on, 11-14.

F

Flat Scale, see Brown or Soft Scale.
Fluted Scale, see Australian Bug.
Four Spotted Lady-bird, enemy of Red Scale, 56.
Fumigation, Horticultural Board work with, 14-17.
house at Cape Town Docks, 26.
report on, 17, 131.
to destroy scale insects, 57, 63, 67, 71, 83, 87, 92, 101, 107, 113, 130.

G

Greedy Scale, article on, 63-67.
description of, 65.
distribution of, 64.
enemies of, 66.
food plants of, 64.
occurrence in Cape Colony, 64.
on imported fruit, 25.
remedies for, 67.

H

Holly and Ivy Scale, see Brown or Soft Scale.
Honey-dew, nature and origin of, 44.
Horticultural Board, Entomologist's work for 14-17.
Hydrocyanic acid gas, see also Fumigation.
as scale insect remedy, 130.

I

Import Regulations of Cape Colony, 23-27.
of Western Australia, 26.
Insect, use of term of, 33.

J

Jumping Plant Lice, article on, 115-116.

K

Kalihari Locust, see, Red-Winged Locust, 19.
Karroo Caterpillars, investigation of, 9.
Knapsack spray pumps, 139-142, 148.

L

Lace-Winged Fly, enemy of scale insects, 46.
Lady-bird, life stages of one figured, 45.
also see under following:—
Chilomenes lunata.
Four Spotted Lady-bird.
Orcus australasiæ.
Rhizobius sp.
Rodolia icoryæ.
Shining Black Lady-bird.
Six Spotted Lady-bird.
Two Spotted Lady-bird.
Variegated Lady-bird.
Vedalia cardinalis.
Yellow Lady-bird.
Lady-birds, Importation of Australian species, 17.
Lecaninæ, general characters of, 35.
Lecanium hesperidum, see Brown or Soft Scale.
oleæ, see Black Scale.
Lime, as remedy for Calandra, 8.
Lime-sulphur-salt wash, directions for preparing, 133.
Little's sheep dip, experiments with, 13.
Locust fungus disease, locusts destroyed by 21.
Long Scale, article on, 71-73.
description and habits of, 71.
distribution of, 71.
enemies of, 73.
food plants of, 71.
occurrence in South Africa of, 71.
remedies for, 73.
Lotis neglecta, see Four Spotted Lady-bird.
Loxostege frustalis, pest on Karroo, 9.

M

McDougal's sheep dip, experiments with, 13.
Mealy Bugs, article on 98-101.
description and habits of, 100.
enemies of, 100.
food plants of, 99.
found on imported fruit, 25.
found on imported trees, 24.
how disseminated, 98.
injuries abroad of, 99.
remedies for, 101.
Mites, classification of, 119.
Mussel Scale, see Brown or Soft Scale, 83.
see Oyster Shell Bark Louse, 73.
see Purple Scale, 67.
Mytilaspis citricola, see Purple Scale.
gloverii, see Long Scale.
pomorum, see Oyster Shell Bark Louse.
Myzus persicæ, curling peach leaves, 106.

N

Nozzles for spray pumps, 143-146.
Bordeaux pattern of, 144.
Climax pattern of, 145.
Cyclone pattern of, 145.
Masson pattern of, 144.
McGowen pattern of, 144.
rods to elevate, 151,
Seneca pattern of, 144.
Vermorel pattern of, 145.
Nursery Inspection Bill, outline of Draft, 27.

O

Oenopia cinctella, see Yellow Lady-bird.
Oleander Scale, article on, 58-63.
description and habits of, 62.
distribution of, 58.
enemies of, 62.
food plants of, 59.
found on imported fruit, 25, 60.
remedies for, 63.
Orange Mussel Scale, see Purple Scale, 67.
Orcus australasiæ, success of introduction of, 18.
Oyster Shell Bark Louse, article on, 73-76.
description of, 75.
distribution of, 73.
food plants of, 75.
found on imported trees and fruit, 25.
occurrence in Cape Colony of, 74.

P

Pachytylus migratorius, notes on, 22.
Paraffine emulsion, experiments with, 13.
formula and directions for preparing, 135.
Parlatoria pergandii, see Chaff Scale, 25.
zizyphi, on imported fruit, 25.
Peach Diaspis, see White Peach-Scale.
Peach Fly, fruits attacked by, 10.
notes on, 10.
Pear Leaf Blister Mite, article on, 126-129.
description and habits, 128.
distribution and food plant of, 126.
injuries by, 123.
occurrence in Cape Colony, 127.
remedies for, 128.
Pear Psylla, account of, 115, 116.
Pharus sex-guttatus, see Six Spotted Lady-bird.
Phlyctinus callosus, see Calandra of Vine, 7.
Phytoptus pyri, see Pear Leaf Blister Mite.
Plant Lice, account of, 102-107.
general character and habits of, 102.
how disseminated, 104.
influence of climate on, 104.
injuries inflicted by, 104.
mode of reproduction in, 103.
natural enemies of, 105.
remedies for, 106.
Psylla pyricola, see Pear Psylla, 115, 116.
Psylidæ or Jumping Plant Lice, account of, 115.
Pumps, also see spray pumps.
selection of, 138-154.
Purple Scale, article on, 67-71.
description of, 70.
distribution of, 67.
food plants of, 69.
found on imported fruit, 25.
found on imported trees, 24.
occurrence in Cape Colony of, 68.
possible importance of, 69.
remedies for, 71.

R

Red Scale, article on, 48-58.
description of, 54.
distribution of, 48.
enemies of, 55.
food plants of, 49.
found on imported fruit, 25.
occurrence in Cape Colony of, 48.
remedies for, 56.
stain produced by on bark and fruit, 52.
Red Spider, article on, 120-123.
description and habits of, 121.
distribution of, 120.
enemies of, 122.
food plants of, 120.
remedies for, 122.
Red-Winged Locust, destroyed by fungus, 21.
notes on invasion by, 19-21.
Remedies, details of, 130-137.
Resin and soda wash, experiments with, 13.
Resin wash, experiments with, 11.
formula and directions for preparing, 131.
hot wash more effective than cold, 12.
quick preparation of wash, 11-12.
winter strength injurious to Peach, 83.

Rhinocola eucalypti, see Blue Gum Louse, 115.
Rhizobius sp. destroying Australian Bug, 97.
Rodolia iceryæ, enemy of Australian Bug, 96-98.

S

Scale Blight, see Oyster Shell Bark Louse, 73.
Scale insects, classification and character of, 34.
food habits of, 42.
how disseminated, 38.
influence of climate on, 42.
injuries inflicted by, 44.
life history of, 36.
natural enemies of, 45.
Schizoneura lanigera, see Woolly Aphis.
Scymnus sp., see Rhizobius, 97.
Selection of spray pumps, article, 138-154.
Sheep dips, experiments with, 13.
Shining Black Lady-bird, 56, 81, 86, 101, 110.
Six Spotted Lady-bird, 56, 62, 81, 97, 101.
Smut on leaves, origin of, 45.
Soda and sulphur wash, formula and directions for preparing, 135.
Soft Scale, see Brown or Soft Scale.
Soot-like fungus on leaves, origin of, 45.
Spray pumps, article on selection of, 138-154.
barrel, 148.
bucket, 148.
care of, 152.
Climax, 150.
desirable features in knapsack, 141.
disadvantages of iron and rubber in construction of, 139.
Eclipse, figure of, 150.
form of, 140.
Galloway knapsack, 142.
geared machine, 151.
hand syringe, 147.
knapsack, 139, 140, 141, 142, 148.
Notus knapsack, 141.
nozzles for, 143.
Starch, as an insecticide, 14-57.
Steam as an insecticide, 58.
Syringes for spraying, 147.

T

Tetranychus sp., see Red Spider.
telarius, 120, 121.
Thea variegata, see Variegated Lady-bird.
Trioza sp., see Citrus Psylla.
Trypeta sp., infesting blackberries, 10.
Turtle Back Scale, see Brown or Soft Scale.
Two Spotted Lady-bird, 80.

V

Variegated Lady-bird, 110.
Vedalia cardinalis, distribution of colonies of, 18, 98.
enemy of Australian Bug, 95-98.
sent to Mauritius, 19.
sent to St. Helena, 19.

W

West Indian Peach Disaspis, see White Peach-Scale, 77.
White Peach-Scale, article on, 76-83.
description and habits of, 78.
discoloration of fruit by, 80.
distribution of, 77.
enemies of, 80.
food plants of, 78.
occurrence in Cape Colony of, 77.
remedies for, 81.
White Eye, as scale destroyer, 47, 62, 101, 105.
White Scale, see Australian Bug, 92.
see Oleander Scale, 58.
Woolly Aphis, article on, 107-114.
description and habits of, 109.
distribution of, 107.
enemies of, 110.
food plants of, 108.
occurrence in Cape Colony of, 108.
preventives for, 111.
remedies for, 112.
Woolly Louse, see Woolly Aphis, 107.

Y

Yellow Lady-bird, as scale destroyer, 56, 81, 105.

Z

Zosterops capensis, see White Eye.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

For the Year 1897.

CAPE OF GOOD HOPE.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1898.

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The Honourable the Secretary for Agriculture.

SIR,—I have the honour to present herewith my report for the year 1897. I would respectfully direct your attention in particular to the suggestion made in the prefatory remarks that an artist be connected with the Department, and to the sentences on page 9 urging the passage of the "Nurseries Inspection and Quarantine Act."

CHAS. P. LOUNSBURY, B. Sc.,
Government Entomologist.

PAGE.

Australian Lady-Birds 22
Continued distribution of *Vedalia cardinalis*.
Unsatisfactory increase of *Orcus australasiæ*.
Attempts to introduce other species.
Appendix A i
Text of "Nursery Inspection and Quarantine Act, 1897."
Appendix B iii
Text of Proclamations restricting importation of plants, fruit, &c.
Appendix C iv
Copy of Board of Horticulture's offer of aid in purchase of co-operative fumigation outfits.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1897.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1898.

PREFATORY REMARKS.

The last annual report from this office, that for 1896, was dual in form. Part I dealt with the general work of the year, such matters as one might expect to find in a formal annual report, while Part II was a paper headed "Some Orchard Pests." This paper was an illustrated one, about 120 pages in extent, and was designed, as the letter of submittal intimated, "to furnish timely information on certain groups of insect pests of considerable importance to fruit culturists." My expectation in thus combining the annual report with a popular paper on injurious insects was to produce a publication which, while answering every purpose of the Blue-book, would also serve as a hand-book to our fruit growers on the insects discussed therein; and to serve both these objects without detriment to either, but rather to the mutual advantage of both. It was anticipated that the popular paper as a supplement to the report would indicate to the law-makers the nature of "studies" conducted during the period covered, which studies occupied time for which account could not otherwise be readily made. And on the other hand, it was expected that the fruit growers, reading the report for the part specially written for their perusal, would have their attention drawn to Part I, and thus become cognizant of the lines of work which this branch of the Department is conducting in their behalf.

Now that the report is published and distributed, I have learned sufficient from the experience to conclude that this form of report is inadvisable, at least under the circumstances in which I am now situated, and the present management of the printing and illustrating of the Department's publications. The annual reports are for submittal to Parliament during the session of the year following that which they cover. My 1896 report was submitted for publication on the 10th March. If it had been in the usual form, this would have been in ample time for presentation to Parliament in the middle of the session; but as it was, fully six months elapsed before the finished report was received from the printer, and long before that time Parliament was dissolved. Numerous delays occurred in the work during this long interval; these were in part due to the more than ordinary care required in the typography, and to the fact that special paper was used, but more largely in one way or another to difficulties in the procural and printing of the illustrations. Whatever the reason, however, the report was not issued when it should have been, and therefore lost much of its value as a "report." It had been planned to have a much larger edition of the report that would have been published under the usual conditions, but a clerical error in the order resulted in a reduction of the intended edition by several hundred copies, so that after the set demands for official distribution had been satisfied, comparatively few English copies remained for sale among fruit-growers. Both objects, then, were in part defeated. The preparation of such a report occupies some time, and unless the objects in view are fully achieved, such time were better spent on other work. As matters stand, an equally long delay would be almost sure to occur in publishing a similar paper, and largely for this reason, no such paper will be submitted for inclusion with this report.

The difficulty in regard to illustrations will never be wholly removed until the department has an artist (or artists) attached to its staff. To explain the why and wherefore of this assertion would take many words, too many for elaboration of the subject here. In another

report submitted (to the Minister) with this, but not intended for publication, the whole matter is discussed in detail. Illustrations are a matter of necessity in popularly treating of different species of insects, and are at least extremely desirable in other publications for farmers. Little can be done in the way of illustrating without the assistance of artists. Most of the Australian colonies employ artists in their departments for agriculture. The New South Wales Department for Agriculture has three on its staff; and the difference between having none, as here at the Cape, and having three as in New South Wales, is exemplified by a comparison of the respective agricultural journals issued by the two departments. Our *Agricultural Journal* for 1897 contained nearly double as many pages as the New South Wales *Agricultural Gazette* for the same period, the figures being 1,550 and 850, respectively. But the New South Wales publication in a single monthly issue often contained half as many illustrations as our journal *for the whole year*. And while nearly four-fifths of such illustrations as did appear in our paper were illustrations taken over from other publications, nearly every one of the illustrations in the *Gazette* were drawn or photographed and engraved expressly for that journal.

Assistance.

An Assistant Entomologist was appointed early in the year, the post being given to Mr. Claude Fuller. Owing to his then existing engagement with the Bureau of Agriculture of Western Australia, Mr. Fuller was unable to enter upon his new duties until September; he was instructed to go to New South Wales before proceeding to the Cape, and to there collect certain species of beneficial insects which we desire to have introduced to this Colony. The execution of this duty occupied several weeks, so that December had commenced before his arrival at Cape Town.

Previous to his short engagement in Western Australia, Mr. Fuller had had about six years' entomological experience in New South Wales; he was assistant to the late Mr. A. S. Olliff, the Government Entomologist, and for

a while after Mr. Olliff's death was Acting Entomologist. His Australian experience will be of great advantage to us here; and as we have already found him to be an enthusiastic, hard, and willing worker, we confidently expect to largely increase the work of this office during the coming year.

Correspondence and Publications.

As during the previous two years for which entomological reports have been submitted, there has been a considerable correspondence with fruit growers and others with this office in regard to injurious insects. Only a small part of this correspondence has been conducted through the Department itself, better results being obtained by direct communication, which obviates the delay otherwise occurring in the receipt of specimens and in the transmittal of advice. Enquiries relative to insects addressed to the *Agricultural Journal* have sometimes been replied to through the medium of that paper, but much more often by private letter.

Contributions in the form of notes and articles have been published in the *Agricultural Journal* from time to time. These have sometimes been illustrated, in all fifteen illustrations having been used, of which seven were original.

Two publications in book form have been written and issued during the year. The first was published as the annual report for 1896. An explanation of its form is given in the prefatory remarks. It was an indexed book of 152 pages, and was illustrated by forty text figures and five full page plates; one of the plates was a lithograph in colours representing a number of injurious scale insects. The second publication was a 29-page pamphlet illustrated by seven figures and two full page plates. It was entitled "Gas Treatment for Scale Insects"; and as its sub-title explained, it treated of the operations of the Board of Horticulture's fumigation outfit, the applicability of the fumigation process in Cape Colony, and embodied a full description of the equipment necessary for fumigation with hydrocyanic acid gas. This pamphlet was published in English at the expense of the Board of Horticulture, and

copies were distributed gratuitously among the members of the various fruit growers' associations and to all applicants. Subsequently, this Department had an edition in Dutch published.

Field Work.

A portion of my time, over one third, has been spent away from the office, either engaged on insect investigations or on other duties connected with official work. The absences, for the most part, have been short, many being for a day or less. While superintending the work of the Board of Horticulture's fumigation outfit (see page 13) which was in operation from the middle of February to June in various places in the Western Province between Cape Town and Hex River, trips of from one to three days duration were made to the scene of operations on an average of about once in ten days.

During April four days were spent in the Darling section of Malmesbury, investigating an outbreak of a vine root-insect, a species of Margarodes (see page 20). June 22nd to July 8th, I spent on a trip to Bathurst Division, made for the purpose of interesting the orange growers in that section in the fumigation process for the destruction of the Red Scale, and to ascertain the condition of the orchards in that section as regarded insect infestation. September 15th to October 12th was also spent in the eastern part of the Colony. First, a visit to Port Elizabeth was made for the purpose of selecting a site for a fumigating chamber near the Customs. Then Bathurst was visited in order to instruct the growers in the working of the newly-introduced co-operative fumigation outfit; and later I travelled to East London by way of Fort Beaufort, Seymour, Alice and King William's Town. Orchards were visited at the different places, and advice given as to the proper treatment for the insect pests found therein. Meetings of the farmers were held at Seymour, Alice and King William's Town, and every endeavour made to induce those interested in the culture of citrus fruits to take up the gas treatment. At East London a site for the proposed fumigation chamber at the Customs was selected, and attention given to other

official matters. On the return journey to Cape Town, a stop of a day was made at the Forest Station at Fort Cunynghame.

The only other extended trip made during the year was to Oudtshoorn. The latter half of December was spent in that district, the principal objects of the visit being to interest the orange-growers in fumigation, to start a fumigation outfit, and to ascertain what insects were troublesome. A fumigation outfit for the district had previously been made, and this was put in operation.

Import Regulations regarding Fruit, Trees, &c.

The restrictions on the importation of fruit, trees and other plants, bulbs, &c., to check the introduction of pernicious insects from abroad, remain the same as in 1896, with the addition of a Proclamation forbidding the importation of coffee plants. A copy of the regulations is published as Appendix B. The Natal Department of Agriculture has adopted regulations similar to ours.

The value of these regulations depends very largely upon the thoroughness with which the provisions are enforced, and much has been done during the past year to ensure thoroughness. At the first of the year the inspections were left wholly to Custom officials; much more desirable arrangements have now been made. At Port Elizabeth the Superintendent of the city parks, Mr. J. T. Butters, has been engaged as examining officer, and at East London the curator of Queen's Park. It is believed that no better qualified parties than these two officers could have been found near the respective ports. At Cape Town, the Surveyor of Customs, Mr. H. le Sueur, is examining officer, but under the existing arrangements, the Assistant Entomologist acts with him in the examination of trees and plants.

Progress has also been made in the provision of facilities for the disinfection of plants and fruits found infested by insects. At Cape Town, fumigation with hydrocyanic acid has entirely superseded the far less reliable method of cleansing by use of soft soap washes. A fumigation chamber was erected near the Searcher's office during the latter part of

1896. The floor dimensions of this structure are about 10 by 20. Corrugated iron was used for the sides and roof. There are two compartments of equal size; the outer one is used for the storage of chemicals and other supplies, and the inner one, spoken of as the "chamber," for the fumigation. The walls of the chamber are of matched boards covered with painted canvas and the door is made to close tightly against strips of felting. A flue containing a close-fitting valve leads from the roof of the chamber and provides for the escape of the gas before the chamber is opened after a fumigation. Supported on cleats attached to the walls of the chamber are forty-eight removable, wire-bottomed trays for the reception of fruit; each tray is capable of holding about 200 fruits in a single layer.

The fruit to be fumigated is placed on the trays, the flue is closed, the gas generated, and the door immediately closed. One ounce by weight of 98 per cent. potassium cyanide is used for each 150 cubic feet of enclosed space, and the gas liberated from this by the addition in a lead vessel of five fluid ounces of sulphuric acid and ten fluid ounces of water. After the expiration of one hour, the flue is opened, and soon afterwards the door. Another half hour is allowed to elapse before the men enter to remove the trays. This treatment has been found to destroy scale insects and scale insect eggs even without the removal of wrapping papers, and that without any injury to the fruit. Chemical analyses by the Government Analyst have been made of fruits thus treated, and the fact established beyond any doubt that all traces of the gas rapidly disappear, and that the treatment is, therefore, in no wise detrimental to the public health.

Trees and plants to be fumigated are laid on the trays or stood on the floor. The gas at the strength used has been found to have no injurious action on dormant deciduous trees, not even on young peach seedlings. This was proved in a series of experiments, the trees being planted after an hour's exposure to the fumes. Pear, apple and peach trees of different varieties were used in the experiment. Citrus trees appeared to be injured to some extent, but our results with these trees were too conflicting to allow of definite conclusions being drawn as to their liability to

injury. The same density of gas has frequently been used for treating citrus trees in orchards without any noticeable damage resulting therefrom.

Being well satisfied with the success of the fumigation method of disinfecting insect-infested fruit and trees at Cape Town, the Department has approved of my recommendation that the same means be employed at East London and Port Elizabeth. I have selected suitable sites at these ports and submitted plans for the buildings; in all likelihood these will be erected within the next few months. Our experience at Cape Town has shown us that larger buildings than the one in use there are desirable. The one I propose for Port Elizabeth is planned to cover a space 20 feet by 25 feet. It is to contain a fumigation chamber 10 feet by 12 feet, a store-room for supplies 8 feet by 10 feet, and packing-room 15 feet by 20 feet. The fumigation chamber arrangements will be much the same as in the Cape Town chamber, the chief difference being the substitution of a hinged window near the top of the back of the space as the means of ventilation in place of the roof flue. The structure for East London will vary little from the one designed for Port Elizabeth.

These fumigation chambers will accommodate from 9,500 to 12,500 fruits at a time. If the imports of fruit in the future justify the measure, an extra set of trays will be furnished, the second set to be filled with fruit while the other is in use inside the chamber. By the use of two sets of trays the process of fumigation may be conducted three or even four times in the course of a working day.

A storage building, 20 feet by 42 feet, for the accommodation of fruit and trees awaiting fumigation is soon to be erected at the Cape Town Docks. For this structure, I have selected a site in the immediate proximity of the fumigation chamber. The fruit will be unpacked and placed on the trays in this building.

The insects discovered in consignments of trees and fruit during 1897 were almost identical with those found during the previous year, and enumerated in the last report. None but the Codlin Moth deserves special mention. This insect was present in a number of consignments of Madeira apples which arrived during our winter. It is one of the most

destructive of fruit pests. The larva or caterpillar bores its way to the core of the fruit. As it is hardly reasonable to suppose that even hydrocyanic acid gas would penetrate the burrows, I recommended that all consignments of apples in which this insect was found should be confiscated and immediately destroyed. These recommendations were approved and several hundred cases of fruit were burned as soon as landed. The option of immediately re-shipping the fruit on some home or Australian bound vessel for consumption on the voyage was offered to the consignees of this fruit, but only in a few instances were any able to avail themselves of the privilege.

Simple as is the disinfection of fruit and plants by means of the fumigation method described, the expense to the consignee is considerable, and the restrictions are having the desired effect of causing the merchants to do their best to import only such articles coming under the regulations as are wholly free of insect infestation. This fact is sometimes well illustrated by the findings of the examining officers. On one occasion, an inspector reported that certain cases of fruit trees consigned from Europe for sale in this Colony were wholly free of injurious insects, while the trees in some other cases sent by the same consignor, and on the same vessel, but consigned to parties beyond the borders of the Colony, were found to be much infested. Evidently the consignor was not aware that we examine *all* consignments landed at our ports, although a previous disagreeable experience had taught him that we would not pass unclean stock for sale within our borders.

Nurseries Inspection and Quarantine Bill.

Considerable attention was devoted during the early months of the year in urging a legislative measure requiring the registration of nurseries of plants and trees and making provision for their regular inspection, and for the subsequent quarantine of portions where proscribed insect pests were found.

The necessity for legislation of this nature was suggested to the Board of Horticulture two years ago in a report from this office published under the heading

"Fruit Pests, and Legislation concerning Them." The result was the introduction of the Bill, the title of which is cited in the heading, during the last session of Parliament. The full text is given in an Appendix to this report. In this form, the Bill was discussed at the Fruit Growers' Congress held at Wellington on May 6th, and was approved by all those present including three nurserymen (about fifty in number) with the exception of a single Stellenbosch gentleman, who attended the Congress purposely to oppose the Bill.

While I am responsible for the principles of the Bill, I am not accountable for all of the details. I think that the distances from infected trees over which quarantine is to extend would be sufficient for the purpose intended if reduced to eight and twelve yards from twenty and thirty as repectively given. Otherwise than as regards these distances, I desire to express myself as unqualifiedly in favour of the whole Bill. I trust that it will be brought forward and become law during the coming session, and not be thrown out, "a slaughtered innocent," at the close of Parliament, as it was last year.

The chief argument used against the proposed Bill is that it is levelled against the wrong section of the community,—that the general public is the chief offending party in the dissemination of insect pests, and not the nurseryman. This argument is absurd. The object of the proposed Act is to check the *dissemination*, that is the *spreading abroad*, of insect pests; and such insects as would be affected by it are those which might be spread by being taken away to new centres with plants. In the spreading of such pests the general public is a passive agent only, while the nurseryman is an active agent. The great majority of such pests are wingless, or possess but slight flying powers. Their spread to new centres depends almost wholly on their being transported attached to a food plant. Through the indifference of the general public to their presence, these pests do spread to a limited extent, it is true; but far greater dissemination is brought about by the active agency of the average nurseryman in one season than by the passive agency of one of the general public in half a century.

There *is* need for a measure to force the general public to use remedial measures against insect pests; but this need is not nearly so great or so pressing as is the need for nursery legislation. The "Plant Diseases and Insect Pest Act, 1895," a proposed Bill to secure the application of remedies for insect pests and plant diseases in districts where the majority of the land owners or fruit growers petitioned for its enforcement, was a carefully drawn measure and deserved support. Its consideration by the Board of Horticulture was recommended by me in the report "Fruit Pests and Legislation concerning Them" alluded to above; but active steps toward again presenting it to Parliament have not been taken.

The distinction we seek to draw between nurserymen and the public has recently been made in a number of American States. Several States now have laws which make it illegal for a nurseryman to sell stock which has not been inspected and certified to be free of insect pests by qualified state officers, that have no laws requiring the general public to take any action against insect pests. We need, and should have, a corresponding law, and this is what is urged above.

The agitation for nursery legislation is having the effect of opening the eyes of some of our best nurserymen to the amount of harm that parties in their business unwittingly do in disseminating pests, and is leading them to adopt measures designed to check the mischief. A few nurserymen are now employing hydrocyanic acid gas to treat their stock, and it is sincerely hoped that others will follow their example. If all nurserymen would adopt and thoroughly carry out this measure, there would be little call for nursery legislation; but, unfortunately, there is no hope that all nurserymen could be persuaded to systematically fumigate their stock, let alone doing such work with the thoroughness absolutely necessary to efficacy. The measure is one which we learn has been adopted by some of the large American Nurseries, and there used with great success. Mr. E. Tidmarsh, one of the longest established nurserymen in this Colony, has proved his interest in the future welfare of the trees leaving his grounds by having a substantial brick fumigation vault constructed. He has

told us that all his stock will be treated therein before being sent away. The building measures six feet by twelve feet inside. Its tomb-like appearance is in good keeping with its use.—See the illustration.

Gas Treatment for Scale Insects.

The summer of 1896-1897 was unusually favourable to the propagation and spread of scale insects, and particularly of the common Red Scale (*Aspidiotus aurantii* Mask.), so destructive to orange and lemon trees. Complaints of the ravages of this insect were received almost daily, and came from almost all parts of the Colony where citrus fruits are grown. It was often reported that the scale had appeared and almost ruined whole orchards within a few weeks; and although such stories were discredited, it was plainly apparent that the ravages of the insect were unusually severe even for so destructive and pernicious an insect pest as this one is during ordinary seasons. A combination of causes was responsible for this increased amount of damage. A diminished rainfall in most sections, coupled with locust ravages in the East and South, had decreased the vitality of the trees, and left them less able to withstand the drain by the insects, and it seemed as if the climatic conditions which proved so unfavourable to the well-being of the trees were just those most propitious to the multiplication of the insect.

The season, then, was a most opportune one during which to push the newly-introduced fumigation process for the destruction of scale insects, and I did not fail to take advantage of the fact. Deeming that if the fruit growers could be got to realize that this treatment was a success they would the more readily adopt recommendations for the control of other insect pests, the work of encouraging the remedy was made paramount to all other matters, and much time and attention given to it throughout the whole period covered by this report.

This crusade against Red Scale was begun in the middle of 1896, on the vote of the Board of Horticulture, and mention of the work done to the close of that year was made in the last annual report. For fumigation, the first

requisite is an outfit of cloth covers and apparatus for the placing of these over the trees to be treated. A large outfit and all necessary appliances was prepared and paid for from the funds of the Board. The Board's primary idea was to have the orchards in some one centre fumigated. and thereby so much improved that all fruit-growers would be led to adopt the remedy. Later it was voted to extend the scope of the work to other centres, not treating all or the majority of the trees as in the first instance, but an orchard here and there. The work of procuring the outfit and of managing the operations devolved upon me. Wellington was selected as the first scene of operations, and about 2,000 trees in 23 gardens and orchards were there treated; before the close of 1896 another thousand trees were treated in Paarl and Stellenbosch.

Operations were necessarily suspended during the first weeks of 1897. They were resumed in late February, when the outfit was taken to Rosebank and worked in a garden close by the Show Grounds on the two days of the Western Province Agricultural Show. Later, orchards at Newlands in the Cape District, at Somerset West and Ban Hoek in the Stellenbosch, at Hex River and Goudini in the Worcester, and at Riebeek West in Malmesbury were treated. In all about 6,600 trees were fumigated before operations were suspended. During the continuance of the work the public was informed of its progress from time to time through the newspapers; and at each centre visited, the fruit-growers and other interested parties were invited to come to the orchards being treated to witness the operations and to become acquainted with the details of the process.

In early June I submitted the report referred to on page 4 to the Board of Horticulture. The operations had clearly established the fact that the fumigation process was a practical success in combating the scale insect enemies of citrus trees despite of the many adverse conditions met with in the Colony, and this fact was strongly urged in the "Gas Treatment" report. Copies of the report were at once distributed in the citrus fruit-growing sections of the Colony and attention also drawn to the work through articles published in the *Agricultural Journal*.

The fumigation of trees with the Board's outfit had been confined to the Western Province, it having been the idea of the Board that the orange-growers in other sections of the Colony would profit equally with the Western growers from the demonstrations, since the success of these would be discussed in the various quarters. But this view of matters was not shared by certain Bathurst growers. They held that the Board, working with Government money, had helped Western growers by treating large numbers of trees for a slight remuneration, and that the same assistance should be extended to them. The Board considered this argument, and finally voted that £200 be set aside for the entomologist to expend in giving demonstrations in the Eastern sections of the Colony.

This resolution of the Board was by no means unanimously made, and I, personally, was much opposed to it. With some other members, I considered that while there was a certain value in affording such demonstrations as had already been given in the Western Province, and were proposed for other sections, the expenditure of the same sum of money in an intelligent effort to establish *local co-operative* fumigation outfits would be vastly more desirable. Late in June a visit was made to Bathurst, and at a public meeting held under the auspices of the Clumber Farmers' Association, I talked with the growers and found that they would favour a co-operative outfit. My views were then placed in writing and submitted to the next meeting of the Board, with the result that the former resolution was rescinded and one adopted which offered substantial inducements to growers to co-operate for the purpose discussed. A circular letter, embodying the offers of the Board and pointing out the advantages of co-operative dealing with this scale insect question, was immediately drawn up from this office. Copies were sent to the secretaries of all fruit growers' and other agricultural societies, and the letter republished in the *Agricultural Journal*. These offers still remain open, and, to give greater publicity to them, the circular is reproduced as an appendix to this report. Briefly, the Board agrees to supply cyanide for fumigation at its cost to the Government, and on certain conditions to subscribe the sum of £25 towards the cost of co-operative outfits.

This method of encouraging fumigation is proving much more satisfactory than the method tried at first. The old method was a dangerous one with which to work. Very naturally the impression quickly got abroad that the Government was making a business of fumigating trees at a merely nominal figure. Numerous requests, and sometimes demands, were received to "come do my trees as you have so-and-so's"; and as it was impossible to comply with these requests, complaints of partiality arose. Another annoyance was the indisposition on the part of not a few individuals whose trees were being treated to do anything to facilitate the work, always because that lawful prey to everybody, the Government, paid the bills. The result of this attitude was increased expense and frequent vexatious delays. None of these difficulties are associated with the new method.

But the procural of a fumigation outfit necessitates not only an outlay of money but an outlay of time and trouble as well. Ready-made outfits are not to be purchased anywhere, let alone in Cape Colony. The pamphlet alluded to above told just what materials were needed and how prepared; but the difficulty of getting these materials and the trouble of evolving them into the desired form were soon seen to be serious obstacles. To remove them there appeared to be no simpler means than for me to offer to have the outfits made in Cape Town. This I did, and by this means have succeeded in inducing many parties to undertake fumigation. The goods for the outfit have been purchased at wholesale prices and care taken to keep all of the expenses reduced to the minimum. The General Manager of Railways conceded 3rd class rates for transportation, and as the parties for whom the outfits were made were charged only the actual cost to me of the materials and labour, they secured their equipments for much less than they otherwise would have done. It takes so much of my time to make the purchases and superintend the making, however, that I do not much longer intend to act as free agent in this way.

Co-operative outfits have been made up for the Clumber Fumigating Board (Bathurst); the Oudtshoorn

Fruit Growers' Association, the Paarl Agricultural Association, and the Stellenbosch Fruit Growers' Association. These outfits consist of 15 to 25 covers each. Aid was also given to P. J. Pentz of Wellington in the equipment of a private outfit of about thirty covers; with this outfit Mr. Pentz has established himself as a professional fumigator, and since the beginning of September has been engaged in the fumigation of trees in different parts of the Western Province. Private parties have also availed themselves of the opportunity to get a few covers for use in their own gardens and orchards, one or more parties in Cape Town, Somerset West, Paarl, and Lovedale having been supplied by me. Other parties have undertaken to treat their trees without troubling me; I have no record of these attempts, but know for a certainty that parties in Goudini (Worcester), Riebeek West (Malmesbury), King William's Town, and Graaff-Reinet have had covers made within the past year.

Chief Insects of the Year.

It would be quite useless, if not altogether undesirable, to mention the numerous insects reported to be damaging crops or otherwise destructive, about which information has been asked and given during the year; but a few notes relative to some of the more noxious pests are worthy of record.

Peach Fly.—This insect, also spoken of as Peach Maggot or Fruit Fly, appears to be now prevalent in most sections of South Africa where stone-fruits are grown. A list of the fruits from which it has been reared at this Office was given in the last report, and to this list may now be added the red Christmas or New Year Plum. The fly which stings Zuur Besjes, the fruit of *Loryalis rhamnoides* (Harv.), an indigenous plant, has been reared and found to be a distinct species; and the same is true of the one which stings the fruit of the very common *Lycium afrum*, sometimes called African Box, and locally about Cape Town, Kalk Bay Bush. That the fly which attacks the fruit of the blackberry, and the one which attacks cucumbers, melons and

other cucurbs are distinct was mentioned last year. The latter insect, which might well be referred to as "Melon Fly," has been reared from cucumbers and bush vegetable marrows (squash) collected in the Oudtshoorn Division.

A great deal about remedies has been written in connection with the Peach and similar fruit flies, but little in the way of actual experiment to test the value of the numerous suggestions has been done. Our species is known in many lands, including the south of Europe and part of Australia. I have attempted to learn through both private and official channels whether the people in these other countries have learned methods of dealing with the pest with which we are ignorant; but from what replies I get in answer to my enquiries, I am forced to the conclusion that we are not a whit more backward than they. This Office is now engaged in a little practical field work in the matter of testing suggestions.

The one means above all others to suggest itself to one acquainted with the round of life and habits of the insect is that the fruit of trees liable to infestation be protected during the latter part of its development by a covering of netting or some other light cloth. A little reflection and perhaps a few trials shows that the simplest and quickest way of thus protecting the fruit is to cover the whole tree with a light netting through which the fly cannot pass, but open enough to permit the circulation of air. That protection could be thus afforded and that without injury to the fruit or the tree was demonstrated during the past season by netting in a nectarine tree. The fruit was plucked in perfect condition while every nectarine on surrounding trees of the same variety was maggot infested.

The utility of this measure depends, of course, on the cost of thus protecting a tree. It is at once obvious that it will not pay to thus protect trees that are not of good varieties and bearing well and the fruit of which is not specially liable to attack. We are this season experimenting with a cheap mosquito netting specially imported from a manufacturer in Connecticut, U.S.A. This netting cost about 1d. a square yard landed in Cape Town. We anticipate that it will keep out the fly and be good for use

during several seasons. The labour of placing the netting over the trees and securing it in position is not great when once the "knack" is acquired. Experiments with odourous substances, hoped to disguise the true character of the trees from the fly's standpoint, are also being tried.

It may be well to remark right here in connection with the subject of remedies or preventives for this destructive pest that the most efficient check would be the gathering and immediate destruction of all "stung" fruit at all seasons of the year. But unfortunately this measure is almost of no avail if not also carried out by near neighbours. Moreover, although we know of a goodly number of fruit-growers—both in the country and about town—who gather and destroy fallen fruit, we would hesitate to name two parties whom we know to carry out the measure so thoroughly that they do not allow a fair percentage of the maggots to pupate and transform to flies beneath their trees. There is generally some good excuse for the negligence—the scarcity and unreliability of labour especially at holiday time or the extreme pressure of work at the plucking season, perhaps—but, nevertheless, the fact remains that the insects have escaped. The destruction of the maggots in the early fruits does much to save the late fruits. Farmers troubled with the Melon Fly, which like the Peach Fly has a succession of generations in a season, would do well to act on this suggestion. We have had a hundred flies from two small marrows; if these flies had lived, they might have caused the destruction of half a hundred or more marrows later in the season.

Codlin Moth.—This is a fruit pest which may some day, in the not distant future, earn for itself a reputation equally as bad as that now held by the Peach Fly. Its introduction to new centres is feared so much that all foreign fruit found infested at our ports is at once destroyed by fire. But it has been present about Graaff-Reinet for a number of years, and it is only a question of time when it will have been spread to all the fruit-growing centres. Last year its presence on a few farms in Stellenbosch was noted. If it were certain that only a few farms in Stellenbosch were infected, energetic steps to *stamp out* the pest would have

been recommended and probably adopted; but, as we feared, the insect is established in other parts of the Stellenbosch Division. It was very recently discovered in a Somerset West orchard, fifteen miles at least from the first orchards. Two of the first growers at Stellenbosch, upon whose places this pest is known are doing their utmost to check it. Their old pear and apple trees have been cut down and burned, and their young trees are banded and repeatedly sprayed. All fruit seen to be infested is at once plucked from the trees.

Scale Insects.—The unusual amount of damage caused by scale insects during 1897 is referred to under the paragraphs on "Gas Treatment for Scale Insects" on another page of this report The Oleander Scale was observed to be excessively common in all of the various centres visited during the past year. The so-called "Seringa" (*Melia azedarach*), is whitened with this scale in nearly all parts of the Colony. Municipal authorities would act wisely is discarding this tree as a shade tree, for not only is it rendered sickly and unsightly by the insect, but a wide variety of garden shrubs and plants in neighbouring gardens contract the infestation and become greatly injured. In the Oudtshoorn District a large proportion of the lemon trees are affected; I have not heard of its occurrence here on orange. A number of instances in which even grape vines have suffered have been reported from different parts.

The White Peach-Scale has been reported from Knysna and Mossel Bay, sections of the country from which it has not previously been recorded. This insect is almost as destructive to the peach tree as the Red Scale is to the orange, and it is highly injurious to many other trees and plants. It is being rapidly disseminated by infested peach trees from several nurseries.

Two ornamental tree scales deserve notice. One *Lecanium minimum* Newst. (so determined by Maskell), a soft scale affecting *Pinus insignis*, *halepensis*, and perhaps other species of Pine, and the other the "Norfolk Island Pine Coccus" (*Eriococcus araucariæ* Mask). Both of these scales excrete copious quantities of honeydew; and, consequently, trees

much infested become blackened with the fungi nourished by honey dew. Such trees from being an ornament become a hideous eyesore. Pine trees affected by the first insect are common at King William's Town and have been noticed at different places in the Midland districts. The Norfolk Island Pine Scale affects the different species of Araucaria, a genus of trees highly esteemed by Colonial gardeners. The insect has been known many years in the eastern sections of the Colony; but only within the last three years, to my knowledge, has it been found about Cape Town, where it is now causing consternation among the gardeners on some of the large estates. I have good evidence that unclean nursery stock is responsible for the dissemination of both of these scale insects.

Margarodes n.sp.—This curious root-coccid was reported in October, 1895, from a vineyard at Olifant's Berg, near Worcester. Last April it was found in three vineyards near Darling, in the Malmesbury Division. At Olifant's Berg the pest is a new one, only one vine having succumbed when attention was first directed to the insect. At Darling one vineyard was visited which has probably been infested for nearly a generation. The ravages of the pest while of serious consequence are not at all alarming. It would not be surprising if future developments showed that the insect occurred in many sections.

A species of Margarodes much like ours in appearance is reported to have become a very destructive vine pest in Chile and Argentine. It has even been said to destroy vines as rapidly as the much dreaded Phylloxera. The French "Le Progrès Agricole" has had considerable to say about it and fears its introduction to Europe. We have made enquiries of Edwyn C. Reed, a prominent Chilean entomologist, who has known of the insect since its discovery about fifteen years ago. He writes that damage is done to vines badly cultivated in soils not suited to their wants, and further says that the vineyard in which the pest was found at first is still healthy and profitable except in a strip of bad ground running through it, the insect not having spread ten feet in ten years. This information goes far in relieving us of the anxiety we were in after reading

the French reports, for we were beginning to fear our Margarodes might turn out to be a new and extremely ruinous pest. It may be of interest to state that the so-called "Golden Beads" or "Ant Eggs" of Ceres and elsewhere which are threaded to form necklaces, are shells of a similar insect.

Paste Beetle.—The Paste or Boot Beetle *(Sitodrepa panicea*, Linn.*)* has for many years been a familiar pest to colonial boot and shoe merchants of this Colony. Early last year attention was directed to its injuries to the bindings of volumes in the colonial archives stored in the basement of the Houses of Parliament. A search soon proved its baneful presence in the book rooms of the different Government departments. The backs of numbers of volumes were perforated by hundreds of tiny, round holes, marking the exit of the mature insects. In a few cases only was the paper of the volumes seen to be injured except near where joined to the covers and backing; so the extent of the damage might be said to be the cost of rebinding. But, unfortunately, a large proportion of the volumes in the archives consist of manuscript papers to which there is not sufficient margin to allow of rebinding; as yet, few volumes here have been seriously damaged but if some preventive is not adopted, irremediable loss may be occasioned in years to come.

The application of corrosive sublimate in alcohol to botanical specimens and to the bindings of books is well known to check the injuries of the insect to parts so treated. The suggestion was made to the Colonial Office to have the books already bound protected in this way as far as possible, and in future to have only poisoned paste used in the binding; up to the present, the suggestion has not been heeded. I have met with a medical practitioner who has had all of his wall papers hung with paste poisoned with corrosive sublimate, and he tells me that the measure has proved entirely successful in checking insect attack; his chief object in view in poisoning the paste was to check the inroads of the Silver Fish (*Lepisma saccharina*, Linn.), an insect well known as a wall paper destroyer in many households.

Australian Lady-Birds.

This subject still occupies some thought and time. The demand for *Vedalia cardinalis* has not yet died away, and many applications for colonies have been filled. Owing to the scarcity of the food, *Icerya purchasi*, the breeding of the insect in confinement is out of the question and reliance is wholly placed on what may be found in the field. Many of the applications are needless, no doubt, but others are prompted by *bonâ fide* local outbreaks of Icerya. A colony of several hundred Vedalia in the larval state was sent to Mauritius in early September and arrived there in good condition after a voyage of over four weeks. The twigs of infested Icerya were pinioned to the sides of a wire cage and the cage kept in a cool place on deck throughout the voyage.

The numbers of *Orcus australasiæ*, the lady-bird successfully colonized at Fernwood, Newlands, in 1895, do not appear to have increased during the year. A colony sent to Wellington has done no better. This lady-bird is one of those "highly recommended" as an enemy of the Red Scale; but an ounce of potassium cyanide would destroy more of the scale than this lady-bird has as yet done for us. Still we are not discouraged and will go on trying to establish imported beneficial species. There is a suspicion that the numbers of the Orcus may be kept down through the unkind attentions of the Butcher Bird; this species of Orcus is a showy one.

Through the agency of Claude Fuller, now assistant Entomologist, we have attempted the introduction, this year, of a number of species. Mr. Fuller was engaged to collect the insects while in Australia. He sent a large consignment, made up of several species in the egg and beetle stages, in cold storage; but all of the insects had succumbed before the vessel arrived at Cape Town. Their mortality was probably due to a too low temperature at some time during the voyage. Later, Mr. Fuller followed, bringing with him in Wardian cases, on deck, strong colonies of *Rhizobius ventralis*, *Leis conformis*, *Orcus chalybeus*, *Cryptolæmus montrouzieri*, and also small numbers of several other species of lady-birds and of *Thalpochares*

coccophagus, a small moth, of which the larva feeds on certain scale insects. Unfortunately, the voyage was greatly protracted, delays occurring at almost every port. When Cape Town was finally reached, it was found that the colonies were considerably weakened. Then despite of all care the survivors died off without progeny until only individuals of ***Rhizobius ventralis*** and of ***Thalpochares coccophagus*** remained. These survivors did not appear to thrive in confinement, and consequently all were liberated in favourable situations in the suburbs. The Thalpochares has taken hold, but we do not feel so certain of the Rhizobius.

FUMIGATION BUILDING, Cape Town Docks.

OF
CALIFORNIA

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FUMIGATION CHAMBER, Cape Town Docks — View of Interior.

Scanned

TIDMARSH'S FUMIGATION VAULT at Botanic Gardens, Graham's Town.

UNIV. OF CALIFORNIA

Meyer's Fumigation Tent for Nursery Stock at Fernwood, Newlands. The trees are stood in the frame and the tent lowered over them.

Public Disclosure

NECTARINE TREES UNDER NETS for protection from Fruit Fly, at Schoongezigt, Stellenbosch.

Document Control

APPENDIX A.

BILL

TO

Check the Dissemination of Insect Pests or Plant Diseases from Nurseries of Plants and Trees.

Preamble.

BE it enacted by the Governor of the Cape of Good Hope, with the advice and consent of the Legislative Council and House of Assembly thereof, as follows :—

Repeal of repugnant Laws.

1. So much of any Law as may be repugnant to or inconsistent with the provisions of this Act is hereby repealed.

Interpretation Clause.

2. For the purposes of this Act the following terms within inverted commas shall, if not inconsistent with the context and subject matter, have the meanings hereby respectively assigned to them, that is to say :—

"Nursery" shall mean any land or premises, whereon are grown or cultivated any fruit or other trees, shrubs or plants, intended for sale or distribution for the purpose of being grown elsewhere.

"Insect pest" shall signify any insect which the Governor may from time to time by Proclamation declare to be an insect pest within the meaning of this Act.

"Plant disease" shall mean any fungoid or other disease which the Governor may from time to time by Proclamation declare to be a plant disease within the meaning of this Act.

Registration of Nurseries.

3. Every nursery shall be registered by the owner or occupier thereof, at the Office of the Resident Magistrate or Assistant Resident Magistrate of the district wherein such nursery is located, on or before the 15th January in each year; and a general registration fee of £1 per annum shall be paid by the owner or occupier in respect of any nurseries owned or occupied by him in such district.

Inspection of Nurseries.

4. Every nursery shall be inspected at least twice a year by an officer appointed for the purpose by the Minister; but, unless deemed absolutely necessary by the Minister, no inspection shall be made during such period between 1st May and 1st October, as shall be fixed for the different areas by Proclamation by the Governor.

Duty of Inspector.

5. It shall be the duty of the inspecting officer to declare under quarantine such part of any nursery as lies within twenty (20) yards of any tree or plant which he finds infested with any insect pest or plant disease, or within thirty (30) yards if such infested tree or plant is over ten (10) feet in height; and such area shall be held and deemed to be under quarantine accordingly.

Quarantine, continuation of.

6. A quarantine proclaimed under the preceding section shall remain in force until the inspecting officer shall at a subsequent regular inspection, or at an authorised examination as provided for in section seven hereof, find the trees or plants within such quarantined area free from insect pest or plant disease, and shall have given his written certificate to that effect to the owner or occupier of the nursery affected; and during such period of quarantine it shall not be lawful for any person to remove or cause to be removed any nursery stock or any plant or any portion thereof from the quarantined area.

Authorised Examination.

7. Any owner or occupier of a nursery having his nursery or any part thereof thus placed under quarantine may upon application to the Minister have his nursery examined free of charge prior to the next regular inspection, to determine whether or not he has been successful in eradicating the insect pest or plant disease, but such owner or occupier must certify that a period of six (6) weeks has elapsed since the last application of a remedy. If additional examinations are desired, they will be made under the same conditions but at the expense of the owner or occupier; and any person who shall give a false certificate under this section shall be deemed to be guilty of a contravention of this Act.

Destruction of Plants, &c.

8. Nothing in the foregoing sections shall prevent any inspecting officer from ordering and causing to be carried into effect the immediate destruction of any plants or trees in any nursery which he finds infested by any insect or other animal pest or by any plant disease, whether the same has been proclaimed or not proclaimed as such under section two of this Act, should he deem such action advisable; provided, however, that any dispute as to the justification of such a measure shall be referred for decision to a committee composed of three members, one of whom shall be appointed by the Secretary for Agriculture, one by the Horticultural Board, and one by the local Fruit Growers' Association, or should no such society exist in the district, by the local Agricultural Society, or in default of such Agricultural Society by the Horticultural Board. Neither the inspecting officer nor the owner or occupier concerned shall be eligible for appointment on the said committee. The decision of the committee must be given within three weeks and shall be final; and until such decision has been obtained the infested portion or portions of the nursery shall be declared and held to be under quarantine as provided for in section five of this Act.

Entry upon Lands.

9. It shall be lawful for any officer duly appointed thereto by the Minister to enter upon any land and to do thereon such acts, matters and things as are necessary or reasonably required for carrying out the provisions of this Act, and any person obstructing, resisting or interfering with any such officer in the lawful execution of his duty shall be deemed to be guilty of a contravention of this Act.

Rules and Regulations.

10. It shall be lawful for the Governor by Proclamation to make, alter or revoke such rules and regulations for the purpose of carrying out the provisions of this Act as may from time to time be deemed expedient, and to impose penalties for the contravention thereof not exceeding a fine of

Penalty Clause.

11. Any person contravening any of the provisions of this Act, or of any rule or regulation duly made and published thereunder, shall be liable to the particular penalty on that behalf prescribed, or if no particular penalty be prescribed then to a penalty not exceeding

Short Title.

12. This Act may be cited as "The Nurseries Inspection and Quarantine Act, 1897."

APPENDIX B.

IMPORT REGULATIONS.

Proclamation 107, 1896.

I. The importation into this Colony from places beyond the boundaries thereof, of all grape vines or cuttings or portions of grape vines, is absolutely prohibited, with the exception of vines or portions thereof, imported by the Government of this Colony under such precautionary measures as it may decide to be necessary.

II. All trees and plants other than vines, and all parts thereof, and all fruits of any description, and all tubers, roots, bulbs, or portions thereof, and all packages, cases, pots, or coverings whatsoever containing such, shall before being introduced into this Colony from places beyond the boundaries thereof undergo a strict examination by a competent officer appointed for that purpose, to determine, as far as possible, the absence of noxious insects and plant diseases which it would be prejudicial to this Colony to allow to be introduced; and it shall be the duty of the consignee to open all such packages, cases, or coverings, for the purpose of the examination aforesaid, and to afford every facility to the said Examining Officer during his examination.

III. On the aforesaid Officer being satisfied as to the absence of noxious insects and plant diseases in such trees, plants, fruits, tubers, roots, bulbs, or portions thereof, and their packages, cases, pots, or coverings, he shall give a certificate to that effect to the consignee; and without such certificate no such articles shall be landed.

IV. All trees, plants, fruits, tubers, roots, bulbs, or portions thereof, or the packages, cases, pots, or coverings in which they may be packed, which shall be found to be infected with any noxious insect or plant disease, shall be cleansed or disinfected by the consignee in the manner prescribed by and to the satisfaction of the Examining Officer; and if not so cleansed or disinfected, or if such disinfection shall be deemed or found to be ineffectual, shall be immediately destroyed.

V. The importation or introduction of any stone-fruit tree, or any fruit, scion, cutting, graft, root or seed, the growth or produce thereof, from the United States of America or the Dominion of Canada is hereby absolutely prohibited, and any one importing or introducing such fruit, tree, or other article the growth or produce thereof, as aforesaid, shall, upon conviction, be subject to the penalty provided in the body of this Proclamation, and in addition thereto the fruit tree or other article imported shall forthwith be destroyed.

VI. Save as in the preceding clause mentioned, all stone-fruit trees, or other articles, the growth or produce thereof, may be imported and introduced into this Colony, subject to the provisions laid down in Clauses 2, 3, and 4, preceding, provided that such consignment of trees or other article be accompanied by a sworn declaration from the consignor that the articles proposed to be imported were not grown in the United States of America or in the Dominion of Canada, and without such declaration no such articles shall be imported.

VII. On the Examining Officer being satisfied as to the sufficiency of the declaration in section VI above mentioned, he shall give a certificate to that effect to the consignee; and without such certificate no such articles shall be imported.

VIII. The Government does not hold itself responsible for any loss or damage that may result from the destruction of the articles under the provisions of these regulations, or from any process that may be considered necessary to cleanse or disinfect the articles or to discover the existence or otherwise of any noxious insect or plant disease.

IX. These regulations shall not apply to canned or preserved fruits.

PROCLAMATION 475, 1897.

The importation into this Colony, from places beyond the boundary thereof, of any coffee plant, or of any cutting, graft, or portion thereof, is hereby absolutely prohibited; and anyone importing or introducing any such coffee plant, cutting, graft, or portion thereof, shall upon conviction be subject to the penalty provided in the body of this Proclamation, and in addition thereto the plant, cutting, graft, or portion thereof, shall forthwith be destroyed.

Any party contravening any of these import regulations renders himself liable to a fine not exceeding £100 sterling, or in default of payment of the fine to imprisonment for a term not exceeding six months. Regulations similar to those in Proclamation 107 have been adopted in Natal.

APPENDIX C.

BOARD OF HORTICULTURE'S CIRCULAR.

FUMIGATION OF CITRUS TREES.

To all Growers of Citrus Fruits in Cape Colony.

The Red Scale is the great drawback to the culture of citrus fruits in Cape Colony. The most successful means for coping with this insect pest is fumigation with hydrocyanic acid gas. The great superiority of this treatment over spraying has been amply proved by the Board of Horticulture, which, during the past nine months, has had upwards of 6,000 trees fumigated in different parts of the Western Province. The Board's work has not only proved the superiority of fumigation as regards efficacy but has demonstrated that the operations can be carried on at less expense than spraying.

Everything considered, fumigation can be most economically and most satisfactorily carried on, in sections where much citrus fruit is grown, by combined effort on the part of the growers. All of the trees may then be treated by the aid of a single outfit operated by a single crew of men who daily become more experienced in their work.

The Board recommends that the fruit growers' and other agricultural societies in these sections of the Colony take up this matter of co-operation and get fumigation outfits into working order at once; or where there is no society or where a society as a whole does not care to take up the matter—that interested parties organize a local club especially for the purpose.

To encourage action in thus securing the fumigation of the trees co-operatively, the Board has decided to import cyanide in bulk and to supply this to societies or clubs which take up the matter at the actual cost; this offer to remain open for twelve months.

Further, the Board will pay £25 toward the cost of the initial outfit if not less than £50 is expended, or half the cost if less than £50 is expended, to the first ten societies or clubs which avail themselves of the offer and agree to the following conditions:—

1. That the society or club consist of not less than five co-operating members and represent not less than 1,000 trees requiring treatment.

2. That, with the view of inducing general fumigation, the rules of such society or club shall be framed so as to admit of other growers joining on payment of the necessary contribution.

3. That the society or club agrees to begin the actual work of fumigation within four months and to fumigate not less than 1,000 trees within ten months of accepting the offer

4. That the work be directed by a committee from the club, which when requested by the Board will submit full reports on the progress of the work and on the expenses connected therewith.

The Board reserves the right to refuse aid to more than one club in any one division.

The Board sends herewith copies of a pamplet* giving detailed information concerning the process of fumigation and of the equipment necessary; but the following general statements will be of further and more immediate service to those considering the above offers.

The trees are covered with air-tight cloths at night, and a gas generated beneath the cover by adding acid to potassium cyanide; the gas thus formed destroys the insects without injury to the tree. The cover is left over the tree from one-half to three-quarters of an hour and as many trees may be treated at one time as can be covered and uncovered during this period.

Four men are generally required to carry on the work—a foreman and three labourers. The only qualifications required of the foreman are that he be a careful, sensible, steady man, and competent to direct the labourers. Previous experience and knowledge of the chemicals are advantageous but not necessary. The Board's outfit has been in charge of a foreman who acquired all of his knowledge of fumigation since entering on the work, and this man has given great satisfaction.

The cost of an outfit depends largely upon the size and number of the covers employed. The expense of a single cover increases rapidly with the size of the tree: thus while a cover for a tree five feet in height may be made for about £1, a cover for a tree 15 feet high would cost nearly £8, and one for a tree 20 feet high about £15. As a number of trees may be treated together without the employment of extra labour, it is economy to have a fair number of covers. In general, if the trees do not run above 16 feet in height, an outfit ample for the requirements of most sections could be prepared at an expense of from £50 to £75.

* Referring to "Gas Treatment for Scale Insects"; see page 4.

Local ownership of the outfit and the employment of local men is urged, since the work must be continued at intervals for a number of years to effect the best results. A single treatment will almost eradicate the insects, but some are sure to escape; attention at a later date will therefore be necessary, and if these after-treatments are given before the trees become much infested the pest will become more and more easily kept in subjection, and fumigation will need to be resorted to only at long intervals. A second treatment will rarely be required within one year of the first, and the increase in vigour and production on the part of the tree—even when it is only moderately infested—will far more than pay the cost of the treatment.

It is desirable that all infested trees in any given locality be subjected to the treatment, in order to minimize the sources from which cleaned trees may become re-infested. Efforts should therefore be made to induce *all* the growers in the locality to take action.

Societies and clubs considering the matter are cordially invited to correspond with the Board. It may be possible to arrange for the Government Entomologist to attend a meeting and discuss the project in detail with the members, and to advise them with direct regard to their local requirements.

Private parties considering fumigation of their own trees are also invited to correspond; the Board may be able to aid them either by supplying cyanide at cost or by advising them where they can secure this and the other necessary supplies at the lowest rates. It may be well to mention that cyanide is still expensive at most chemists, but that prominent Cape Town firms have promised to supply it at very reasonable rates as soon as the demand admits of their importing it in bulk. The Board hopes to be instrumental in creating such a demand.

A. A. PERSSE,
Secretary, Horticultural Board.

1st August, 1897.

CAPE OF GOOD HOPE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

For the Year 1897.

CAPE TOWN:

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

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YEAR 1898.

CAPE OF GOOD HOPE.

Presented to both Houses of Parliament by command of His Excellency the Governor.
1899.

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TABLE OF CONTENTS.

Letter of Submittal. PAGE

General Statement 1
Classification of Work of Office.
Why our Farmers are slow to adopt remedies for pests.
Field Work and Investigations.
Natal Fumigation Outfit.
The Departmental Artist.
Acknowledgment of Assistant's Services.

Correspondence and Publications 5
List of Contributions to Agricultural Journal.
Source of Journal Illustrations.
Correspondence.

Insect Legislation:—

Nurseries' Inspection and Quarantine Bill 7
Its Urgency.
Some Destructive Pests which might be introduced and disseminated.
Ravages of San José Scale in Maryland.
Inspection of nurseries highly desirable even if not combined with quarantine of infected areas.
But quarantine a public safeguard.
Where proposed Act would be onerous.
Botanical Gardens not desirable nursery sites.

Orchard Legislation becoming more necessary 9
Horticultural Boards urged to consider.
The Codling Moth factor.

Import Regulations 9
Suggestion that there be a Chief Inspector.
Fumigation of all imported trees recommended.
Slight relaxation of stone-fruit prohibition urged.
Recommendations approved by Horticultural Board.
Text of proposed amendments.
A flaw in the proclamation.
One unfortunate result of unrestricted importation in Natal.

Fumigation Treatment for Scale Insects 14

Orchard Fumigation:—
Formation of Co-operative Fumigation Clubs.
Government Grant to such Clubs.
List of Clubs.
Assistance to them in getting Outfits.

Management of the Co-operative Outfits 15
The arrangements with Managers, and Charges.
A Manager a necessity.
Arrangements for Transport.

Cloth for Fumigation Covers 16
Light Duck oiled used for early Outfits.
Heavy Duck unoiled now preferred.
Objections to oiled Cloth.
Details in making Covers.
Covers not gas-tight.
Charges of Chemicals for Small trees must be increased.
Willesden Rot-proof and Water-repellent Cloth
Unbleached Calico.
Greasing Cloth inadvisable.

PAGE

Manipulation of Sheet Covers 18
Alterations in details of uprights.
Simple device for hoisting a single sheet.

Generating Dishes 19
Substitution of China Dishes for Leaden ones.
Their many advantages.

Extent of Orchard Fumigation 19
Aggregate number of Trees treated.
A good showing for the Cape.
Satisfaction with process general.

Fumigation of Deciduous Trees 20
Not generally recommended.

Nursery Fumigation Chambers 20
Several erected in 1898.

Amount of Cyanide required for Chambers 20
Extraordinary vitality of Mealy Bug.
Uncertainties of Fumigation.
Plants not injured by reliable charges.

Hydrocyanic Acid Gas for Glasshouse Fumigation 22
How conducted to avoid all injury to Plants.
Experiments by Colonial Parties suggested.

Hydrocyanic Acid for Dwelling Fumigation 24
A dangerous and unwarranted practice.

Natural Enemies of Insects:—

Distribution of Vedalia 24
How obtained and despatched.
Fee for sendings and reasons therefor.
Number of Colonies sent out and to where.

Sending of Vedalia to Portugal 25
Australian Bug about Lisbon.
Appeal for its Lady-bird Enemy.
How sendings were packed.
Success of Vedalia in Portugal.

Sending to St. Helena 26
Failure of past sendings to establish the species.

Failure of Australian Lady-birds to become established.. 27
Continued failure probable.
Large sendings by qualified agent needed.
Efficient Red Scale Enemies unknown.
Time hardly ripe for expensive introductions.
Probable great future for International Exchange of Natural Enemies.

An attempted introduction from Ceylon 27
The voyage too prolonged.
The Lady-bird a valuable one.

An attempted introduction from Australia 28
Another failure.
Further sendings promised.

Exportation of Shining Black Lady-bird 28
A gratifying success.
Food and Value of the Lady-bird.
Sending to Ceylon.
Details of a novel method of packing.
Report of condition on arrival.
After three months.
Pulvinaria psidii and Lecanium vivide attacked.
Possible value of the Lady-bird.
Sending to New South Wales.
Condition after three months.
Eight weeks' confinement and still alive.

PAGE

Other Scale Pest Checks 31
A parasite of the Red Scale.

Parasite of Lecanium oleæ 32
Possible value to other Countries.

Fungus Checks of Scale Insects 32
Not unknown in the Colony.
An important American species.

Strange behaviour of Peach Scale in St. Helena 32
Once a plague, now unknown.
Was it our White Peach-Scale?
Probably still to be found.
Search is being made.
White Peach-Scale in South Africa and Mauritius.
It is becoming Cosmopolitan.
Possibility of finding powerful natural check at St. Helena.

What Checks Woolly Aphis in England? 34
Apparently not altogether climatic conditions.
Once highly injurious there.
Perhaps there is an ally to be found

Notes and Studies on the Season's Pests:—

Scale Insects 35
Some that are standing pests.
Pine-apple Mealy Bug.
Two beneficial Scale Insects.
Orthezia insignis.

Codling Moth 37
Present distribution.
Illustrative Placard being published.

Fruit Fly 37
Plentiful, 1897-1898; almost absent, 1898-1899.
New Food Plants.
Netting to protect Fruit.
Large quantity imported.
How applied; may be pinned on.
Picking up fallen fruit *the* remedy.
Must tell in extensive orchards.

Odours to deter Oviposition 39
Asafœtida.
Tar and Soda.
Eucalyptus and Cresoline.
Quassia and Syrup.

Calandra of the Vine 40
A failure with gas-lime.
Suggestions for Lime experiments.
Related Insects in other Countries.
Removal of rough bark as an accessory remedy.
Life history of the Calandra.
Cultivation favours it.

Ticks 43
Bont Tick, Amblyomma hebræum:—
Its remarkable prolificacy.
Duration of incubating period.
Failure to rear.

Bont-Leg Tick, Hyalomma ægyptium (?):—
Confusion with Bont Tick.
Red Tick, Rhipicephalus evertsi.

Blue or Blood Tick, Rhipicephalus decoloratus:—
Distinct from Australian and American species.
Common but not feared.

PAGE

Fowl Tick, Argas reflexus (?) :—
Identity with Foreign Fowl Ticks.
Man-attacking Tick, Onithodoros savignyi.

Woolly Aphis 46
A troublesome pest.
On Pear trees.
Growing of Tobacco suggested.
The winged generation.

Plant Bugs 46
The Bagrada Bug, Bagrada hilaris.
Antestia variegata, a fruit puncturing Bug.
Holopterna valga, the twig wilting Bug.
Aspongopus nubilus, the Melon and Pumpkin Bug.
Remedies for Plant Bugs.

Miscellaneous Lepidopterous Pests 48
The Cabbage Plutella.
The Potato Tuber Moth.
Cut-worms or Mest-wurmen.
Heliothis armiger, the Tomato Worm.
Karroo Caterpillar or Risper.
Antheræa tyrrhea, the Wellington veld pest.
Antheræa cytherea, a pine tree pest.
Dendrolimus capensis :—
A Gypsy Moth scare.
Grape Bag-worm.
Acræa horta.
Cossus tristis, the Apple and Quince borer:—
At Capetown.
A borer in Osier and Willow.

Miscellaneous Coleopterous pests 52
Heteronychus arator, the Keever beetle.
Adoretus capicola, a Grape pest.
Malacosoma borrei.
An Otiorhynchid Grape pest.
Haltica indigacea, the Blaauw-biesje.
Odontionopa sericea, Odontionopa beetle.
Epilachna chrysomelina, a Melon pest.
Epilachna similis, a Grass pest.
Mylabris beetles.
Other miscellaneous beetles.

Other miscellaneous pests 55
Pear Leaf Blister Mite.
Bryobia Mite.
Citrus Psylla.
Tree Froghopper.
Nematode Worms.
Pear Slug :—
Paris Green note.
New arsenical spray compounds.
Phylloxera.
Locusts.

Appendix A.—Abstracts from Agricultural Journal contributions bearing on need of legislation for Orchard pests, particularly the Codling Moth.

Appendix B.—Details concerning the Oudtshoorn and Trappes Valley Fumigation Outfits.

Cape Town, May 10th, 1899.

The Honourable the Secretary for Agriculture.

SIR,—I have the honour to present herewith my report for the year 1898. Your attention is specially directed to the remarks under "Insect Legislation," and I sincerely trust that you will be disposed to exert your influence in securing to fruit growers the much needed measures therein advocated.

Summer being the busiest season for my vocation, and the date mentioned for the opening of Parliament this year being much later than usual, I took the liberty of giving more urgent matters precedence to the preparation of my report ; this accounts for its not being earlier submitted.

CHAS. P. LOUNSBURY,
Government Entomologist.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1898.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1899.

REPORT OF THE GOVERNMENT ENTOMOLOGIST FOR THE YEAR 1898.

General Statement.

The work conducted by the office may be classed as follows :—

1. The dissemination of knowledge concerning and urging the practice of remedial measures of known value for insect attack.
2. Investigations to discover new remedies and to demonstrate the value under our conditions of those advocated by entomologists in other countries.
3. Studies on the life history and habits of insects with a view to the practical application of the knowledge obtained.
4. Miscellaneous work such as the collection of Vedalia lady-birds to send to parts of the country where outbreaks of Australian bug occur, the introduction and export of beneficial insects, the examina-

tion of plants imported through Cape Town, and the preservation of insects collected or received with the view to their ultimately forming a departmental reference collection.

The first class of work, though the least attractive in itself, is given the preference for it is in response to the most pressing need. It might be called *gross* entomological work and the need for it in a sparsely settled and comparatively new country (agriculturally) like this is far greater than in more populous lands of older civilization. Our colonial farmers are much behind the times as far as insecticidal measures are concerned, and are undeniably slow in adopting such measures when they hear of them. The explanation for this circumstance among those with whom I have come in contact is not, however, in the majority of cases, apathy towards new ideas or indifference towards progressive measures, but rather is the natural conservation which makes the average farmer everywhere procrastinate in the adoption of improved methods and appliances until their practicability is sharply brought home to him, and he realizes keenly that their adoption would be to his material advantage. Not alone farmers but most men in all walks of life instinctively follow much and lead little ; they generally wait for an associate to take up a new idea before they start. Farmers become acquainted with new methods by their reading, but few put these into practice until they have seen others do it and thus learn how to apply them to local circumstances ; they are inclined to ignore precept and to wait for example. Now the conditions which surround our Cape farmers are far less favourable to the production of leaders to set the example than are the conditions in England, America or even in the more progressive parts of Continental Europe. Sparsity of population, lack of manufacturing interests, of agriculture along special lines, of skilled labour, all in one way or another are against it. If our farmers had wide-awake, breezy, reliable agricultural papers circulating among them, as American farmers have by the dozen ; if they had manufacturers enquiring minutely into their wants and adopting their productions to the special requirements ; if they had intelligent in place of cheap labour ; if the land were thickly settled thus giving a demonstration of the utility of a practice by one farmer the maximum influence through the same practice being adaptable with little or no change to

his neighbour's conditions; then would we find the seemingly apathetic colonial farmer as responsive to new ideas as the farmer anywhere else. The work of the entomological office has been modified to meet the peculiar circumstances. When advice is sought by a farmer regarding measures to check an insect pest, it is felt that not only should careful consideration be given the matter, however trivial, but that an earnest endeavour should be made to have the applicant act upon the recommendations given him, the idea in view being that this man may, if properly assisted, set an example that may be followed. Acting under this belief, the recommendations and suggestions to correspondents and others seeking information are made as far as possible with particular reference to the individual case. Encouragement for them to take action is given by the mention of where the necessary materials and appliances may be purchased and at what cost, and frequently by placing their orders for the various articles needed, and even by personally attending to the purchases. This very indirect entomological work has necessitated keeping in touch with the merchants selling insecticidal appliances and materials employed in insecticides, and also suggesting to these merchants that for which there is likely to be a demand. It is impossible to estimate the value of this assistance to our farmers. In some cases, it is time and trouble lost. Even when urged, many farmers will not write to say what they have done and how they have succeeded, or if their example is followed, yet it often comes to my knowledge that some seed falls on good ground and grows satisfactorily. Though seemingly petty work I believe it important and class it first in the duties of the office. The leading measure urged during the year has been the fumigation of citrus trees, and the assistance given parties in its promotion is alluded to on page 14.

Between one-fourth and one-third of my time has been spent away from office on investigations or otherwise engaged in official work. Six weeks, April 15th to May 28th, were spent in one trip to the eastern half of the Colony. Fumigation outfits were then started at Cathcart and Kei Road, and others arranged for at Graaff-Reinet and East London, and studies were made on a number of important insects in the districts visited. In October a few days were spent at East London as the delegate from the Department of Agriculture to the Eastern Province Fruit Growers' Congress. A report on the proceedings was written for

the *Agricultural Journal* on my return. Part of November and December were occupied in the preparation of a fumigation outfit for the Natal Government, and in instructing its manager from Natal in its use. The outfit was made to consist of twenty-two covers ranging in size from one requiring but twelve square yards of cloth to one requiring over three hundred square yards. The Natal Department of Agriculture had heard of and became impressed with the value and importance of the fumigation work against scale insects being conducted in this Colony, and desired to introduce the remedy among the Natal growers of citrus fruits. It appealed to our Agricultural Department for assistance, and I was deputed to prepare an outfit of covers and all the necessary incidentals and then to fully instruct a representative from the sister colony in all details of the work. To give this manager experience in the practical work, I arranged to fumigate a large orchard in the Paarl district. Hither the plant was taken, and about fifteen hundred trees, varying from five to twenty feet in height, treated under my supervision. While this work was undertaken solely that the Natal Manager might get needful experience, it gave me a long desired opportunity of testing on a large scale the style of covers and table of chemical quantities which I had been recommending ; the inferences from the test will shortly be made public.

The examination for insect pests and plant diseases of plants and trees imported through Cape Town, and of all plant products subject to our import regulations received at the General Post Office, has been conducted by this Office. As a result of observations, I have suggested amendments to the regulations which, if adopted, as now seems probable, will render them more efficacious for their purpose. Fumigation buildings to facilitate the disinfection of insect-infested imports at Port Elizabeth and East London, and a special building at Cape Town for the storage of imports awaiting examination and fumigation, from specifications by me, have been constructed during the year and are now in use.

Before closing this general statement regarding the work of the office, I desire to express my appreciation of the action of the Department in appointing a Departmental Artist, a matter which I strenuously urged in my last annual report and in unpublished official papers. The gentleman selected for the new post, Mr. Arthur Rich, is an artist of exceptional ability, exceptional in that he combines the

highest artistic attainments in his representations of objects with scientific accuracy in every detail, and thanks to previous experience he is peculiarly fitted for zoographical work, such as should constitute the bulk of his employment at the Department.

It is, finally, my pleasant task to formally acknowledge my high estimation of the services of the Assistant Entomologist, Mr. Claude Fuller, F.E.S., and to place on record his constancy in striving to please, and his zealous devotions to his chosen life-work.

Having no other office assistance, routine duties have fallen somewhat heavily on Mr. Fuller, but he has found time to assist me in much special work. The technical study of the stock-infesting ticks has occupied a portion of his time, and has borne fruit in the determination of the more important species as noted elsewhere. His skill with the pencil, and incidental great usefulness to me in a special line, is manifested by the numerous illustrations from his drawings which appear in the *Agricultural Journal* ; the merit of these is self-evident.

Correspondence and Publications.

It has been my endeavour to do thoroughly my part towards making the official publication of the Department interesting and attractive to its readers, and to this end illustrated original matter has been contributed nearly every month on some entomological subject of more than ordinary importance at the time. A list of these contributions is given below.

Contributions to "Agricultural Journal."

Title.	Illustrations.	Form.	Issue.	Pages.
				Vol. XII.
Spray Pump Notes	Eight; two original.	Article.	Feb. 17	221-6.
Scale Insects on Ornamental Trees and Plants	One; original	Article.	Mar. 3	260-3.
Another Introduced Scale Pest (*Orthezia insignis* Douglas)	Five; four original.	Article.	,, 31	390-6.
Do. do. do. do.	..	Note.	April 14	452-3.

CONTRIBUTIONS TO "AGRICULTURAL JOURNAL.—*(continued)*.

TITLE.	Illustrations.	Form.	Issue.	Pages.
Bryobia Mite and Fumigation ..	..	Letter.	April 14	457-8.
Netting for Fruit Trees—To protect fruit from Peach Fly and birds	Two; one original.	Article.	,, 28	509-12.
Another Introduced Scale pest ..	..	Note.	June 23	779-9.
				Vol XIII.
Tobacco for Woolly Aphis	One.	Note.	July 7	42-5.
The Bagrada Bug of Cabbage and Allied Plants	One; original	Article.	,, 21	101-5.
Remedy for Mest-Wurmen ..	One.	Article.	Aug. 4	157-60.
Winter Spraying	One.	Article.	,, 4	160-3.
Two Fruit Tree Beetles	Two; original	Article.	Sept. 1	275-8.
Fowl Ticks	..	Note.	,, 1	278.
Wax Insect (*Ceroplastes* sp.) ..	..	Letter.	,, 1	286.
Insect Notes—Pear Slug: Paris Green	One.	Article.	,, 29	398-402
Do. do. Codling Moth in Madeira Fruit	..	Note.	Oct. 13	467-8.
Worms in Stuckvats	..	Letter.	,, 13	477.
Codling Moth	Nine; five original.	Article.	Nov. 10	597-616
Citrus Psylla	One; original	Note.	,, 10	616-8
Portuguese Potatoes and the Potato Moth	..	Note.	,, 10	618-9.
Melon Aphis	..	Note.	,, 10	619.
Eastern Province Fruit Growers' Conference	..	Report.	,, 10	620-6.
Vine Beetle (*Adoretus capicola*) ..	..	Note.	,, 24	719-20.
Thorn Tree Scale	One; original	Note.	,, 24	721-4.
The Codling Moth (Additional Notes)	..	Note.	,, 24	724-6.
Fumigation Supplies	..	Note.	Dec. 7	780-1.
The Fruit Fly; pick up the fallen Fruit	..	Article.	,, 22	843-6.
Melon Destroying Insects	..	Letter.	,, 22	859.

The contributions covered eighty-five pages of letter press. They included thirty-four illustrations, eighteen of which were from original drawings and eight others from drawings copied or adopted from engravings published elsewhere. With a single exception, the original illustrations appearing in the *Journal* during the year were all prepared under the direction of this office, and included the drawing or redrawing of twenty-five figures by the assistant entomologist. Reprints of all the important papers were made at the time of publication.

The correspondence of the office has slightly increased. In all a few over a thousand official letters were written, seven hundred and eighty-five of which pertained to insects. This correspondence has been carried on without clerical assistance, no account being kept of papers dealt with through the formal departmental channel.

Insect Legislation.

The Nurseries Bill.—Despite the hearty support given it by the fruit growers at their annual congress both in 1897 and 1898, the Nurseries Inspection and Quarantine Bill, drafted by the Board of Horticulture with my assistance, seems farther from becoming an Act now than it did two years ago. It was not even introduced into Parliament at the last session. I again urge its importance and reiterate the statement made in last year's report that, with a certain modification of the area over which the quarantine is to extend, I am unqualifiedly in favour of its provisions. Without some form of nursery inspection, pernicious insects may be introduced and unwittingly spread all over the country before their occurence in the Colony has been discovered. Even under present circumstances our fruit industry needs careful fostering. The fruit fly in the stone fruits, the codling moth in the apples and pears, and the scale insects in the citrus fruits are heavy enough burdens for the infant industry to shoulder without the addition of San José scale, oyster-shell bark louse, pear psylla, or peach borers, most destructive insects that might easily be introduced, notwithstanding the precautionary examination of imported plants, and disseminated from the nurseries for a number of years before their pernicious character forced its attention on either the nurserymen or their customers. In the little state of Maryland, U.S.A., over 50,000 orchard trees have been killed by the San José scale during the last

four or five years. The state entomologist in a recent report mentions that the proprietors of one extensive peach orchard had started to uproot all of their 28,000 trees because of the ravages of this tiny pest ; the trees were between seven and ten years of age and should have been in their prime. Were an orchard of one-fifth this size to be destroyed here by a scale pest, the effect on the industry might be calamitous ; and for all that is known, this and other very injurious insects to which the term " new " might be applied may even now be spreading from nurseries. An inspection of all nurseries by a government officer having a knowledge of insects and diseases liable to be spread with trees is highly desirable, even if the inspection be not coupled with a quarantine of infected areas or other compulsory measure to arrest the distribution of the dangerous pests. The nurserymen would then at least be made cognizant of the presence of noxious insects and plant diseases, and they would in the majority of cases take steps to remove or minimize the evil. But a systematic quarantine of infected areas until the cause is removed, as the Nurseries Inspection and Quarantine Bill proposes, would far better safeguard the interests of the public, and would not bear heavily on careful nurserymen except in those instances in which the nurseries are small and located in town centres or in botanical gardens. In such situations, its provisions might often prove burdensome through surrounding ornamental and fruit trees serving as breeding grounds from which pests continually spread to the nursery stock. No sympathy need be felt for private nurserymen growing stock for country planting on town sites because of probable hardship from a Nurseries Inspection Act. With regard to nurseries in connection with municipal botanical gardens, it may be said that some of them have done useful and highly creditable work in the past in introducing and disseminating improved varieties of fruit trees. But the nursery business has now become a field for private enterprise, and private nurserymen have amply demonstrated their ability to do all that botanical garden nurserymen can possibly do and much more ; in short, the necessity for a public institution to conduct a nursery business other than for its own profit has passed away. Though they formerly played a well-nigh indispensable part, time has brought changes, and now no sound argument can be advanced to justify the continued existence of the botanical garden nurseries. Therefore, why need heed be paid to the

annoyance which, for the public weal, the proposed legislation may cause them ?

Orchard Legislation.—The necessity for orchard legislation is rapidly increasing now that the codling moth is becoming a factor with which fruit growers must reckon. No active steps toward obtaining an orchard measure have been taken since the " Plant Disease and Insect Pest Bill " was brought forward in 1895. That orchard legislation is desirable has been persistently advocated by me from the very first, and I am now strenuously urging the horticultural boards to thoroughly consider the matter, and I trust that a measure embodying the essential features of the 1895 Bill will soon be brought before Parliament. Observations on this subject were made in the article on the codling moth published in the *Agricultural Journal* for November 10th, and for convenience these are included in this report as an appendix.

*Import Regulations**.—Our import regulations are, without question, the means of retarding the introduction of many foreign pests, and are thus shielding the Colony from indeterminate but in the aggregate probably great losses which these pests would cause. The very fact that all imported plants and fruits are subjected to inspection at our ports is in itself an important safeguard, for in a large number of instances it secures a careful selection of the articles. As regards the inspections, these are now much more ably conducted than formerly, but I venture to suggest that still greater efficiency would be attained if the examining officers were responsible, not as now simply to the official head of the Department, but to a subordinate officer of the Department, a " chief inspector," one of whose special duties it should be to keep himself thoroughly posted on the pests liable to infest the fruits and plants. It must be remembered that the examining officers give but a small portion of their time to the inspection duties, that they are not economic entomologists or botanists, fruit experts or trained inspectors, and that, therefore, although they are admittedly well chosen men it is really requisite that they receive instructions direct from one who, to use a street expression, is more " in the know." The argument may be advanced that any of the Department's advisory officers may now recommend to the executive any suggestion or instruction he may think it advisable to have given to the examining officer ; but the

* The text of the present regulations was published in last year's report.

fact is no officer can do much of this without making himself appear more or less meddlesome. I speak thus freely in regard to this matter because I have had much to do in devising the present facilities for the disinfection of infested imports, because the pests concerned are almost exclusively insects, and, therefore, such as I am directly interested in, and lastly because the fruit growers depend on me to do my utmost to increase the effectiveness of the regulations.

The provision of facilities for gaseous disinfection of plants and fruits at the three principal ports has made it possible for me to make the recommendation with some assurance of its adoption, that the regulations be amended to require that all consignments of trees be subjected to fumigation with hydrocyanic acid gas whether or not infesting insects were discovered. I have long considered the inclusion of a clause to this effect desirable, and the recommendation was reserved only because of the lack of facilities for rendering it practicable. The principal reason for my considering this precaution desirable, lies in the fact that certain yet foreign to us, but almost cosmopolitan pernicious scale insects are very inconspicuous on their food plants and that, owing to the generally soiled and often musty condition of the trees on their arrival, a slight infestation by these insects might easily be overlooked. The adoption of the suggestion would not obviate the necessity for a careful examination, since one would be still required to determine the presence or absence of pests whose destruction would not be rendered certain by the fumigation.

At the same time (August last) it was recommended that the regulations be further amended to permit a very limited importation under strict Government supervision of new varieties of stone-fruits from states and provinces of the United States and Canada in which the peach yellows and peach rosette* do not occur. The regulations as they at present stand debar all importations of stone-fruits from these countries, the reason for this drastic provision being the fear of introducing the peach yellows. This disease, however, and the peach rosette as well, is entirely restricted to eastern and central sections, and has nowhere appeared within a thousand miles of the Pacific coast, and legislation has been enacted in the west to guard against its introduction. There is room, therefore, for a qualification of our regulations sufficient to permit the limited introduction of new

* The peach rosette is a perplexing disease which is second only to peach yellows in destructiveness to stone-fruits.

varieties as suggested. Nowhere else in the world than on the Pacific slope is more intelligent effort being directed to the improvement of fruit by selection and hybridization. "Novelties" are constantly coming forward, and among these are many of the market sorts of the future. Particular attention has been paid to plums and prunes, stone-fruits in which our fruit growers feel a keen interest; in the former because shipments to England have been found highly remunerative, and in the latter because there is a strong colonial demand at good prices for which to cater. Some recent productions in prunes promise remarkably well, and even bid fair to completely oust the old continental varieties. If our import regulations were sensibly amended, our nurserymen and fruit growers would be enabled to introduce these new varieties as soon as they are placed on sale, and thus at once be able to test their suitability to our climate and conditions. But as matters stand we must wait, perhaps several years, until the varieties are introduced to France, the Australasian colonies or other lands outside America, and from there get our stock. The varieties, meanwhile, will not have improved with the multiple changes in climate that they have experienced, and instead of their being obtained from wholly reliable sources as in all probability they would be if imported direct, they may reach us from doubtful nurseries, and thus endanger us with new pests. The area infested by the peach yellows is known, and there is not the slightest danger of our getting it with new varieties of stone-fruits from states where it has never been reported. Writing to advise the California State Board of Horticulture on the question of safety in permitting introductions from states within the infected area, Professor B. T. Galloway, Chief of the Division of Vegetable Pathology, of the United States Department of Agriculture, said: "If yellows exist in some parts of a state and not at all in others, I should consider it safe to import from non-infected regions, provided that they are not very close to infected regions, and provided it can be shown that the buds as well as stocks come from healthy localities." Surely if this high authority on plant diseases considers it safe to introduce from states partially infected, we have no reason to hesitate in relaxing our regulations to allow of very limited introductions, and that under Government supervision, from perfectly clean states?

Both of the proposed amendments were communicated by the Department to the Horticultural Board to get its

views, and the Board in turn referred the matter to a committee. After careful deliberation this committee reported itself in sympathy with the proposals, and further recommended that the restrictions suggested for stone-fruits should be extended to cover trees of all kinds from wherever imported. The report was adopted and transmitted to the Department. As finally amended the proposals read :—

1. That the importation of fruit trees and trees of all other kinds, seedling stocks excepted, be hereafter permitted only when the following conditions are complied with :—(*a*) that a permit be specially procured from the Agricultural Department stating what it is desired to import, from where and from whom ; (*b*), that the importation be limited to ten trees or separate parts of trees of any one variety, and to a maximum of one hundred trees or separate parts of trees of all varieties to any one party in one season ; (*c*) that the importation be exclusively limited to varieties not catalogued by any Colonial nurseryman ; and (*d*), that each consignment be accompanied by a sworn declaration stating that the stock was carefully examined at the time of packing and found entirely free from boring insects. That the importation of stone-fruit trees from the United States and Canada be hereafter permitted except from the states and provinces where peach yellows or peach rosette exists or has existed ; but that each consignment of stone-fruit trees or parts thereof from wherever imported shall be accompanied by a sworn statement declaring that the stock was not grown, nor produced from seed grown, nor packed in a state or province in which either of the diseases mentioned exists or has existed.
2. That the import regulations make compulsory the fumigation of all consignments of trees, together with the packings and enclosing cases of the same, whether or not infesting insects are discovered during the examination.

The matter of these amendments has been elaborated here because there is still danger that they may be unfavourably considered by the Department. Since the proposals were introduced the Eastern Province Horticultural Board has been formed, and this new body has been asked

for its views on the questions. There is a grave probability that the new Board, from not having a full knowledge of the bearings of the case, not knowing that the peach yellows is totally non-existent in the American West, nor how important it is that we get new varieties from there, may decide that in their estimation any relaxation of the prohibition is uncalled for and injudicious. This seems the more probable when it is considered that our eastern sections are not nearly so well adapted for the commercial growing of stone-fruits as our western districts, and, therefore, that the east would have little to gain by supporting the amendment. Opposition from the Eastern Province Board might lead to the matter being dropped, or, at least, its settlement long delayed. I trust that this public statement will convince the fruit growers in all sections that in suggesting the changes I have acted in what I believe to be their interests, and in impressing upon all that the Western Province Board has given the propositions its support.

Our import regulations may require amendment in yet another way. The proclamation covering them applies only to importations *by sea*. If the colonies in which the other South African ports are situated possessed regulations similar to our own this peculiar discrepancy would be of small account, but so long as we stand alone in the matter, it admits of our regulations being readily circumvented. An attempt was made in 1897 by our Agricultural Department to induce Natal to co-operate with us, and at the time the effort appeared successful, the Natal Department of Agriculture writing in December of that year that regulations similar to those of this Colony had been adopted and would be soon put in force ; recently, however, it has transpired that these regulations still remain inoperative. There is now no check on pests which might come with plants landed at Durban (or at Delagoa Bay, either) and brought overland into this Colony. Nor, what is of greater consequence, does there appear to be any legal restriction on the introduction of stone-fruits from any part of America, or of grape vines from anywhere, providing they come through this channel ; if the introduction of these plants were attempted at any of our ports, the plants would be confiscated and the consignee would be liable to a heavy penalty under the proclamation.

That Natal would benefit from the enforcement of regulations similar to ours may be inferred from a paragraph in *The Agricultural Journal and Mining Record* of that Colony

for February 17th, 1899. This paragraph contained a letter from a Georgia, U.S.A., firm of nurserymen (Georgia, by the way, is a state in which peach rosette is prevalent) which opened as follows :—" We note in one or two letters that some of the consignees are troubled with borers in their trees, and would suggest the following as a preventative." Then follows the formula and directions for preparing and applying a deterrent wash. The letter is clearly indicative that Natal has recently imported a borer pest, and I may add that of all tree pests, other than a few which infest the fruit, tree borers are the most destructive. The introduction of the pest into South Africa is much to be regretted. And if the Natal Government does not take steps to secure the eradication of the insect immediately and to prevent a re-occurrence of the circumstance, it is sadly neglecting its duty to the fruit growers.

Fumigation Treatment for Scale Insects.

Orchard Fumigation.—The work began two years ago in furthering the fumigation method for the destruction of scale insects on orchard trees, has been vigorously prosecuted at every opportunity throughout the period covered by this report. In districts where the growing of citrus fruits ranks as a commercial industry, the endeavour has been to get the local fruit growers' association to operate a fumigation outfit or to have a few growers unite privately for this purpose. On the conditions that these co-operative fumigation clubs consist of not less than five members, representing at least a thousand trees requiring treatment, that this number of trees be fumigated within ten months, and that the facilities be extended to non-members on reasonable terms, the Government has made each a grant of £25 towards the purchase of the initial outfit. Where co-operation has seemed impracticable, private parties have been urged and encouraged to procure small outfits for the independent treatment of their orchards.

There are now nine co-operative clubs with outfits at work, and of these, eight started operations during 1898. In the sequence in which they commenced, these are : Trappes Valley (Bathurst), Paarl, Oudtshoorn, Stellenbosch, Cathcart, Kei Road (King William's Town), Ncera (East London), Graaff-Reinet, and Van Staadens (Uitenhage). The covers and most of the other special apparatus required for these co-operative outfits and for fifteen private outfits

were made to order under my direction and supplied to the respective parties practically ready for use ; this step was of great assistance to all and without the promise of it, the attempt to form most of the clubs would have been a vain task. A few private parties have bought cloth and made covers for themselves as directed in letters to them, and it has been learned that some have made covers from the instructions published in my " Gas Treatment " pamphlet. Most of the fumigators depend on the Department of Agriculture for their supplies of cyanide, this being sold to them at its cost to the Government. Parties resident in the South African Republic, the Orange Free State, Natal and Rhodesia and such outlying parts of the Colony as Namaqualand and the Transkei have written to get full particulars regarding the treatment, and in a few instances have availed themselves of the information given them and the offer of assistance in getting the covers made. Mention of a large outfit made up for the Natal Government is made elsewhere.

Management of Outfits.—The arrangements for the management of the different co-operative outfits varies widely, a circumstance for which this office is in large part responsible, for it was considered desirable to ascertain by experiment which of the various plans that suggest themselves prove best in practice. At Paarl and Stellenbosch, the outfits are owned by the local fruit growers' associations and are in charge of managers with whom it is stipulated that orchards be properly treated at a fixed tariff, and that a fraction—one-third or one-fourth—of the gross proceeds be given to the association, the remainder being retained as remuneration and to pay for chemicals and labour ; the charges to the general public are slightly more than to members of the association. The Kei Road, Ncera and Van Staadens outfits are owned by small clubs, the members of which subscribed the initial costs and, in return, have free use of the apparatus. Outsiders pay sixpence a tree treated for the hire of the outfit, and both members and non-members pay the cost of the chemicals used and for the services of the manager. The members of the Cathcart club contribute one shilling for each tree they desire to treat, to cover outfit expenses, and pay for the chemicals at cost. They altogether dispense with management expenses, each farmer attending to the treatment of his own trees after receiving instruction in the use of the apparatus from the honorary secretary of the club, a medical practitioner. This plan has thus

far been the least satisfactory of the several described, a paid manager seemingly being a necessity. The Trappes Valley people raised the initial fund by a subscription list. They pay a manager £12 a month, and treat trees at a charge which covers the cost and allows for a renewal of the outfit (see appendix). The subscribers had the first use of the apparatus but have had no other advantage over outsiders. Oudtshoorn has the most business-like arrangement. The whole fumigation plant is the property of the fruit growers' association, and was paid for by the membership fees. Members' trees are only treated, but residents of the district may easily become members. The trees are treated at tariff rates and, while these are high, there is no cause for complaint, since any surplus over expenses is association property. The manager is paid £12 a month and is allowed a saddle-horse.

All of the clubs depend upon the farmers for the transport of the apparatus to or from their orchards. The Oudtshoorn association owns a special wagon, but with this exception the clubs depend on the farmers for both vehicle and draught animals. Except at Oudtshoorn, dependence is also placed on the farmers for two or more boys to help with the work, and in several cases he is required to board and lodge the manager without charge.

Cloth for Fumigation Covers.—The covers for the early outfits were made of eight or ten ounce American cotton duck of the best quality and were lightly coated with a mixture of one part turpentine to four of linseed oil. Sometimes raw oil was used and sometimes boiled ; there appeared to be no great difference in result, but if more covers were to be oiled preference would be given to the boiled. Raw oil without turpentine was applied to a number of covers ; exposure to the sun for several weeks was required to dry these, and then the cloth was found to be not only stiff but very weak, slow combustion apparently having taken place. The oiling of the covers at the best, increased their weight by two-thirds without, of course, adding anything to the strength, besides it invariably stiffened the fabric to some extent, thus making it less easy to handle, and more likely to tear. These objections to oiling the cloth might not be serious if the covers were always to be used on well-grown trees, and by experienced hands ; but they proved decidedly serious where the covers were employed in treating misshapen, long neglected trees by parties with little or no previous experience. Our need was soon clearly seen to

be covers combining the maximum of strength and pliability with the minimum of weight. The necessity led me to experiment with unoiled covers of heavier cloth, and after several weights were tried, what is known as No. 10 American duck was adopted for large covers, and No. 8 for small ones. For several months, however, the lighter cloth, No. 10, has been used for both large and small sizes. Different brands of this cloth are sold, but only the most closely woven ones are adapted to our purpose. It weighs between fifteen and sixteen ounces to the square yard, and after it is well shrunk with water no interstices should be apparent when it is held between the eye and the sun. The sewing is done by machine with Singer Company's linen thread, single seam for tent covers and double for sheets ; a short stitch is advisable, and No. 45 or heavier thread should be used for the sheets. It was found difficult to manipulate sheet covers of oiled cloth fifty feet in diameter, but even new hands have had no trouble in managing fifty-seven foot sheets of No. 10 duck unoiled. In only one respect are the oiled covers superior to the stronger and more durable unoiled ones, and that is with respect to their gas-retaining properties. The gas escapes through even the oiled cloth, but much more rapidly through the unoiled, even though the latter appears equally tight to the eye. Despite of this defect, however, covers of the unoiled heavy cloth have given far greater satisfaction and will probably continue to be used. But observation of the results obtained by use of the customary dose of one ounce of cyanide to 300 cubic feet of enclosed space (for red scale) has convinced me that allowance must be made for the loss of gas by diffusion through the covers. It is observed that the proportion mentioned cannot be relied on to destroy all the scale on small trees when the unoiled covers are employed. A larger dose is advisable even under heavily oiled covers, while for use with the unoiled, I am of opinion that the proportion should be gradually increased from one ounce to 300 cubic feet for a tree sixteen feet in height, to one ounce to 125 cubic feet for a tree six feet in height. The surface through which the gas escapes increases in proportion to the space enclosed as the dimensions of the tree decreases ; hence the necessity for giving small trees proportionately greater doses. There is more than four times as much surface to the space encompassed by the cover in the case of a 4×3 ft. tree than there is in one 16×12 ft. When trees are dosed with the quantities of chemicals recommended in the old tables, there is little

odour of the gas under the two smaller sizes of tent-form covers forty minutes after the reaction has taken place, while under the large sheets, it is often disagreeably strong ninety minutes after, thus clearly demonstrating the error of basing the table of quantities on the cubic contents alone*. A number of covers of a Willesden rot-proof and water-repellant duck of the same weight and quality as the ordinary No. 10 duck have been tested, and have been found to better retard the permeation of the gas, though not to a very marked extent. The cloth was less easily sewed than ordinary duck, and its odour of ammonia when handled in the making gave much annoyance to the parties who sewed it. The naturally green colour faded quickly under the action of the cyanide fumes. It is yet too early to decide definitely whether or not it is preferable to the ordinary cloth in the long run. The cost in London was about equal to what is paid for the other in Cape Town. Several parties are using covers of oiled unbleached calico and express themselves well satisfied. Dressing a cover with fat as wagon sails are waterproofed was tried by the manager of the Oudtshoorn outfit and found inadvisable ; the dressing never dried and soon weighted the cover with an accumulation of adhering soil and rubbish.

Manipulation of Sheet Covers.—The style of uprights for raising and lowering the sheet covers described in the " Gas Treatment " pamphlet is still employed, but the long poles are now tapered from $2\frac{1}{2}'' \times 4''$ at the base to $1\frac{1}{2}'' \times 4''$ at the top and are twenty-six feet in length, and the braces are cut six feet instead of five ; a simpler device finds a few champions among orchardists working with a single sheet. The idea is to gather half of the sheet in loops of rope and by means of poles as levers to raise this gathered half until it is directly above the tree to be covered, while the loose half hangs to the ground ; then to slacken the loops and thus permit the suspended folds to open and fall forward. Two long light poles, pointed at the base and at least three feet higher than the tallest tree to be covered, two pulley blocks, and a quantity of rope is all the apparatus required. Two small holes, about the width of the trees apart and in line with, and equally distant from the centre, are cut in the sheet ; the tops of the poles are passed a few inches through the holes and are bound securely in this position, one end of a long rope is then fastened to the projecting top of the pole, and the other passed out around the margin of the sheet back to

* Copies of the Amended Table on cardboard, with brief but explicit directions for fumigating, may be had on application to this office.

the pole beneath the hole, and through a pulley block there secured. When these tackle ropes are adjusted to both poles, half of the sheet lies in two loops, and hauling on the free ends of both ropes contracts the loops and thus draws the half of the sheet into folds. One or two guy ropes are attached to the tops of the poles to assist in raising and lowering them. Preparatory to covering a tree, the sheet is spread out and the half of it toward the tree gathered into folds as described ; the poles are laid parallel, one at each side, with the feet in line with the trunk and braced in some manner to prevent their slipping. Four men are required to raise the cover, two for each side ; one lifts the pole while the other with a guy rope assists him and works to prevent the pole slipping to one side. To relieve the strain on the cloth, it is customary to connect the tops of the poles with a rope a few inches shorter than the width of cloth between them. When the cover is in a position over the tree, the poles are, of course, beneath. This manner of manipulating the cover was first practised by Mr. W. E. Murray of the Graaff-Reinet district and by him explained to me. I found him covering trees fully eighteen feet high, using dried flower stalks of American aloe (*Agave americana*) as his poles.

Generating Dishes.—China pudding basins are now substituted for the lead dishes first used as generating vessels, they are much less costly and are preferable on the score of lightness, also the smooth and rounded bottom inside is in their favour, it tending to keep the cyanide floating in the acid during the reaction and thus rendering its complete decomposition most probable. The bottoms of lead dishes soon become battered and flattened ; under this condition lumps of cyanide may become stranded when the acid is shallow and the dissolution thereby checked.

Extent of Orchard Fumigation.—The aggregate number of orchard trees treated during the year by the fumigation process is known to be above 24,000 and may be as high as 27,000. This a large number for the Cape when it is considered how small, scattered, and of uneven growth our orchards are, and that the treatment is in its infancy with us. The Trappes Valley club reports that it fumigated 8,678 trees in fifteen months in 22 orchards ; and the Oudtshoorn club, 4,127 in 110 orchards in ten months. Satisfaction is everywhere expressed with the results, and some of the unsolicited statements as to the success of the treatment are more flattering than patent medicine testimonials ; the fear that the scale would soon render the growing of citrus fruits unprofitable has passed away.

Fumigation of Deciduous Trees.—The employment of fumigation to destroy scale insects on deciduous trees has not been specially recommended, since these trees may be sprayed thoroughly during the winter with efficacious washes at a relatively lower cost. But fumigation may sometimes be advantageously substitued for spraying in the case of deciduous trees. If the treatment is performed during the winter, it may be carried on during cool days under darkened covers without injury to the trees, and doses strong enough to destroy all stages of even egg-laying species safely administered.

Nursery Fumigation Chambers.—The example set by the curator of the Grahamstown Gardens and by Mr. Henry Meyers, of the Fernwood nurseries, Newlands, in providing facilities for the fumigation of nursery stock—to which allusion with illustrations was made in last year's report—has been followed by Mr. H. E. V. Pickstone, of Groot Drakenstein, Messrs. Gowie Brothers, of Grahamstown, and by the curator of the Graaff-Reinet Gardens. The two latter nurserymen have erected brick vaults very similar to the one at the Grahamstown Gardens. Other nurserymen have promised to have chambers ready for use at the commencement of the selling season. All our nurserymen should be provided with fumigation chambers, not only for the treatment of stock being despatched to their customers, but that they may ensure the destruction of any scale insects which might infest stock received by themselves, either from abroad or from other South African nurseries, and also for the disinfection of scions and cuttings. If root cuttings of apple were fumigated before being grafted upon, many of our nurserymen would be spared much of the annoyance caused them by the woolly aphis.

Experiments to ascertain amount of Cyanide required.—There is room for considerable investigation in ascertaining the amount of cyanide to a given space necessary to generate sufficient gas to destroy different insects exposed in an air-tight chamber such as a nurseryman would use, and if an opportunity presents itself, a little work along the suggested line will be conducted during the present year. A few experiments performed last year brought out some interesting facts. In an approximately air-tight closet, the gas from one ounce of cyanide to 750 cubic feet in two hours failed to appreciably affect adult scale insects, but destroyed fully ninety-five per cent of woolly aphis on stems of apple. One ounce to 450 cubic feet for one hour appeared to be fatal to

the red scale in all stages and to all but the eggs of the oleander scale (*Aspidiotus nerii*), white peach scale (*Diaspis amygdali*) and greedy scale (*Aspidiotus camelliæ*). The same strength for two hours did little more. One ounce to 300 cubic feet for one hour proved fatal to all stages of the species named and to the eggs of an oleander-infesting mealy bug (*Dactylopius sp.*), but a few of the adult mealy bugs survived an hour's exposure in one ounce to 200. When any of the species used in the experiments was much massed on the infested surface, the destruction was strikingly less thorough than when the scales occurred singly. A few adult females of the greedy scale in a mass of their kind on the fruit of a large fruited Solanum (*Solanum aculeastrum*) failed to succumb when exposed for an hour in one ounce to 300, while not one among many hundreds of scattered individuals lived through an hour of one ounce to 450. Similarly some larvæ of the oleander scale sheltered in the scurf of old scales of its species on American aloe (*Agave americana*) survived one in 300. These observations confirm what has been suspected with respect to orchard fumigation, that a dose fatal to every scale insect on moderately infested trees sometimes proves insufficient in a very badly infested case by an occasional scale escaping through the protection afforded by a covering of other scales. A diligent search shortly after the treatment has often failed to reveal the presence of a single survivor among thousands of dead scales, but that a few had escaped the general destruction would become apparent after the lapse of three or four months. The decreased potency of the gas as it penetrates masses was prettily illustrated by its action on the eggs of the Australian bug (*Icerya purchasi*). This scale insect, be it remembered, deposits a very large number of eggs in a sac-like outgrowth from the posterior of its body, and the eggs within this ovisac are embedded in a mass of protective cotton-like filaments. Comparatively weak gas destroyed the eggs nearest the end of the sac, but had no effect on those further within. As the doses were increased in successive tests, larger and larger proportions of the total number succumbed, but those in the layer immediately against the body survived even one ounce of cyanide to 200 cubic feet, and a very few in the largest sacs withstood even a half hour's exposure of one ounce to 150 cubic feet. A number of young apple trees badly infested with woolly aphis were exposed to the gas after sousing the roots in water to remove the soil. One ounce to 450 cubic feet for one hour

appeared at the time to be thoroughly efficacious, but after the lapse of three months the roots of even those exposed to one to 300 for an hour and of those to one to 200 for a half hour were again much infested. The film of water about the roots or the traces of soil still clinging to them had evidently served to protect a number of the insects. Altogether, the series of tests though incomplete indicate that in the disinfection of nursery stock care should be taken to give the gas free play among the trees, and that it is advisable to employ much stronger doses than what are known to be fatal under ordinary circumstances. Dormant deciduous stock is not injured by exposure to four times the normal orchard proportion for citrus trees—one ounce to 300 cubic feet. The cost of charging a small chamber is a mere trifle, and, this being the case, my present recommendation to nurserymen is to use not less than one ounce to 125 cubic feet of space when treating deciduous trees. The strength which citrus trees will stand without being injured has not been determined, but fully dormant stocks are not injured in the least by one ounce to 250, nor more than the tips of growing trees by one ounce to 300 ; under favourable conditions at least, the latter portion is fatal to all stages of the scale insects known to affect citrus stock in the nurseries of this colony with the exception of the Australian bug and mealy bug.

Hydrocyanic Acid Gas for Glasshouse Fumigation.—An officer of the United States Department of Agriculture has been experimenting off and on for the last four years with hydrocyanic acid gas as an insecticide for the destruction of various kinds of insect pests which affect plants in glasshouses, and following his lead a number of gardeners have adopted this fumigant. It is said that it has been found possible to destroy practically every insect without injuring so much as a leaf or flower. Even mealy bugs and *Orthezia insignis* are said to be destroyed without the least injury to so delicate a plant as coleus. A description of the process, taken from an American source, was published in the *Gardener's Chronicle* for July 16th last, and from this I glean the following particulars. Three parts of acid to two of boiling water are used and the cyanide added while the acid-water mixture is bubbling with heat ; this secures a very rapid evolution of the gas, and necessitates the use of a large generation vessel to prevent slopping over the sides. The exposure is a short one, the house being opened as much as possible from outside as soon as twenty-five minutes have

expired. For each cubic foot of free space enclosed, one and eight-tenths grains of cyanide are used ; which, if troy grains are intended as seems most probably, is equivalent to one avoirdupois ounce to 200 cubic feet. "All damp must be driven out of the house, and the plants should be quite dry in their foliage before commencing to fumigate them with the cyanide, because if there is any moisture on the leaves and young growths, they are liable to get scorched. All being dry and in good order, the process may be carried out with perfect safety to the plants ; and houses full of palms, ferns, roses, violets, carnations and other tender plants and flowers have been treated as described with the most successful results, the insects being destroyed and neither a flower nor a leaf hurt in the least."

To what extent this innovation in glasshouse fumigation has come into practice I do not know, but its discussion in several gardeners' papers has attracted wide attention to it. Opinion concerning its practical value is diverse, largely on account of the risk both to the operators and the plants, but there seems to be no question that when certain precautions are fully observed the results will be all that is claimed above. However, I do not refer to the use of the gas in glasshouses here in order to recommend its general adoption in this country. I am not prepared to do that, not having experimented to satisfy myself just what precautions are necessary to ensure entire safety to the plants. But I do suggest that nurserymen and florists who have fumigation chambers, and gardeners who have closets or rooms they could safely use as chambers, experiment on pest-ridden plants to which they can afford to risk injury, and demonstrate to their own satisfaction the economy of the process. The essential feature to prevent injury to the plants seems to be the absence of moisture, both in the air and on the foliage. Our climate is so mild a one that it is unnecessary to have glasshouses here built and kept in such good repair that they are approximately gas-tight ; and it naturally follows that the proportion of them which may be closed tight enough to answer as fumigating chambers is not large. Further, owing to the exceedingly poisonous character of the gas, its use in conservatories attached to dwellings is dangerous. For these two reasons it is unlikely that the gas will become a popular glasshouse fumigant in the Colony. Still, florists, curators of public gardens, and gardeners on large estates, may find its use, particularly in special chambers, a welcome improvement on their present methods of dealing with scale insects and aphides on house plants.

Hydrocyanic Acid Gas for Dwelling Fumigation.—I mention the subject principally to condemn this dangerous practice. It has been suggested, not unnaturally, by the highly successful results obtained in destroying orchard pests by the gas. Almost needless to state the chief intent of house fumigation is to effect the destruction of that unmentionable, but in this Colony by no means uncommon insect which is recognised in scientific circles by the appellation *Acanthia lectularia.* The gas, when used at double the strength for orchard treatment, does have a most beneficent effect on the creatures but it does not often accomplish a complete riddance. The construction of most colonial houses is too faulty for thorough work, currents of air entering crevices and diluting the gas in them to a degree at which it is not deadly ; by virtue of this, a few of the vermin or their eggs are tided through the deadly visitation to their mates. Extermination being improbable, there is little to induce one to give this remedy preference over less dangerous measures, and I think that parties, other than experts who know just what risks are assumed and what to do in case of an accident, are wholly unwarranted in employing it. Even experienced hands had best avoid its use under ordinary circumstances. Hydrocyanic acid gas is not a poison to trifle with, and as a warning to those whose enthusiasm over its unrivalled insecticidal properties leads them to meditate its use in their dwellings, I invite their consideration to the fact that I have learned of several instances within the last year of parties having narrowly escaped death when such use was being made of it. The danger is not in the generation of the gas but in the subsequent opening of the rooms for ventilation, and in the risk of parties entering the rooms unawares during the operations or too early after they are over. The danger attached to orchard fumigation or the use of the gas in special chambers is infinitesimal in comparison. In connection with these uses of the gas, I have not heard of a single accident occurring in this country, and only one, a temporary prostration due to deliberate disobedience, in America.

Natural Enemies of Insects.

Distribution of Vedalia.—As in former years some time has been given to the collection and dissemination of vedalia (*Novius cardinalis*) the notorious Australian bug destroyer. No attempt is now made to breed the insect in confinement, experience having proved it to be more economical to search

for and locate patches of the host insect in the town and suburbs, and to periodically examine these patches until the lady-bird puts in its appearance. The bark, twigs, or leaves bearing the scale insects and their enemy are then cut away and despatched to the applicant at once, with instructions for him to tie the pieces immediately among the scale insects on a much infested branch of one of his trees. In this way the vedalia is introduced to new surroundings with very little disturbance to its operations, even though its destination may be several days' journey from Cape Town. Ten shillings is charged for a sending, but the charge is neither designed to meet the expense of collecting lady-birds nor to represent our estimate of their value, but solely to discourage needless applications. Were it not for this check, much valuable time would have to be wasted in procuring collections for parties resident in and about Cape Town. The vedalia has been so thoroughly distributed about South Africa by intentional dissemination and by natural spread, and has so generally established itself that no extensive outbreak of its host, the Australian bug, is anywhere probable and least of all in the vicinity of large settlements. But it often happens that the pest is introduced to an isolated town or farm where its enemy has never been brought, and that it there becomes a power for considerable damage to vegetation, and, again, there seems a likelihood, to judge by the many urgent applications received year after year from the same places, that the vedalia is sometimes winter-killed at high altitudes of our interior.

Forty-one packages of the lady-bird, each containing from twenty-four to one hundred larvæ, were despatched to twenty-eight addresses during the year. Larvæ are preferable to beetles for sending away, as they better endure confinement and are less likely to wander away one from another when liberated at the journey's end. About as many sendings were made to addresses outside of the Colony as to those within, it being customary to entertain applications from the neighbouring States on the same conditions as those from within the Colony. Two sendings were made to destinations outside South Africa and deserve special mention. One was to Portugal and the other St. Helena.

Sendings to Portugal.—It appears that the Australian bug had been accidentally introduced into the country about Lisbon, had there become an established pest and for several years had been causing an immense amount of trouble. The first heard of the matter at this office was through the Portu-

guese Consul, who came with a cable message from his Home Government asking if we could supply the lady-bird enemy. Mindful of the obligation South Africa was under to another country for our original supply of vedalia, I was, of course, pleased to have this opportunity of extending the courtesy, and so expressed myself to the Consul. It was several weeks, however, before he received instructions relative to the despatching of our proposed sending and of the urgency of the matter. The task of collecting was undertaken without delay, and although it was late in our season, an abundance of food and full three hundred larvæ were procured within the next ten days. The larvæ and food were divided into five lots and each lot packed in a paper-lined wooden box measuring 3in. × 8in. × 10in. inside, the twigs bearing the precious freight being wedged or tacked into place to prevent their being shaken about. Explicit instructions relative to the treatment of the lady-birds on arrival at their distant destination were drafted and delivered to the Portuguese Consul with the boxes, and on the afternoon of the day it was packed—March 23rd—the consignment left by mail boat. The consul was recommended to send three of the boxes by post, and the other two in the vegetable room of the ship, and this he promised to have done. The mail time to Lisbon *via* London, it may be remarked, is about twenty-two days. In due time word was received that the five boxes had arrived and that the vedalia was in splendid condition. No further advices have been received from the consulate, but from other sources it has been learned that the vedalia is now repeating in Portugal the remarkable performance of Australian bug clearance that has made its name a household word at the Cape.

Sending to St. Helena.—The consignment of vedalia to St. Helena was of less importance. Colonies from here have been sent to the island from time to time, one as late as 1896, but owing to unexplained causes, the lady-bird failed to become established or so at least the Governor of the island gave us to understand in his formal request to our Government for further sendings. Three boxes made up as were those sent to Portugal, were sent in early September. The larvæ had been in the boxes a fortnight before they were liberated on the island. The acknowledgment stated that they arrived in good condition, and as nothing to the contrary has since been heard, it is presumed that this 1898 sending has been at least temporarily successful in subduing the scale pest.

Failure of past introductions of Lady-birds.—I have this summer failed to discover any progeny from the lady-birds whose introduction into the Colony was heralded in previous annual reports, and there is little hope that any is to be found. It is feared that we will continue to fail in effectually establishing exotic species until we have a qualified agent travelling to collect the desired varieties and to bring them to the Cape, unless we send them in competent charge, in very large numbers of each kind. What we want most are efficient natural enemies for the red scale and other Diaspinæ but where these treasures may be obtained seems to be known to no one and it is even doubted that such exist. There are, however, a number of Australian and Indian lady-birds which might prove of greater importance in destroying these scales than any of our native species, and these I should like to have colonized here. But as there is no assurance that the benefit derivable from them would be commensurate with the expense of sending a special agent—perhaps it would be necessary to send several times—I feel forced to be content at present with such humbler attempts as have been made during the last few years. As it happens, a lively interest in the project of colonizing lady-birds is evinced in several countries, and in a few years we may have successful experiences on the part of some one of these to guide us in an elaborate venture in what is at best largely a game of chance. This being a small country and one not over wealthy, there is no shame in waiting for others to " build the road." It is not out of place to remark here that that part of the study of economic entomology which concerns the relations between insect pests and the forces which tend to their suppression is yet in its infancy, and with a great future before it ; through the knowledge being gradually acquired all over the world by a multitude of workers, the time is coming, I venture to predict, when a systematized international exchange of the natural enemies of insect pests will be possible and practicable and immensely to the advantage of agriculturists.

Attempted Introduction from Ceylon.—During July last, Mr. E. E. Green, Honorary Government Entomologist of Ceylon, sent me by letter post a small consignment of *Chilocorus circumdatus*, Gyll. The insects were about to assume the pupal stage when despatched, and were enclosed in a commodious wooden box along with food. The box reached Cape Town in six weeks, but the confinement had proved too long. The beetles had emerged and died without leaving eggs. Mr. Green has promised to try again

when opportunity offers and hopes to eventually succeed in getting a few to reach here alive. This lady-bird is one which is said to have proved a remarkably profitable introduction to the Hawaiian Islands, it there having almost eradicated the purple scale (*Mytilaspis citricola*), a scale injurious to citrus trees in Natal and, to a slight extent, in this Colony. Recent American papers state that an expert has been sent to the islands to collect numbers for colonization in Southern California.

Attempted Introduction from Australia.—The late date at which this report is being written makes it possible to here record the outcome of the latest attempt to introduce species from Australia. A consignment of about one hundred and twenty-five beetles arrived February 7th by the steamer *Aberdeen* from Sydney. The captain had been interviewed at the time of his previous call at Capetown and had signified his willingness to take charge of any sendings we might arrange to be brought to him on his next home trip. The sending we succeeded in obtaining was made up by Mr. W. W. Froggatt, the Government Entomologist of New South Wales, and consisted almost entirely of *Orcus chalybeus*, a lady-bird partial to the kinds of scale insects that give us most trouble. It was planned by us to have the box come in the fruit chamber, but owing to a mishap to the cooling apparatus, the captain kept his charge on deck. The food provided proved insufficient to meet the requirements under the warmer conditions, and when the box was opened at Capetown thirty-two days after its despatch, not a solitary living lady-bird in any stage was found. The disappointment is acute, for our plans had been carefully made. Further consignments are promised.

Exportation of Shining Black Lady-bird.—While so unfortunate in the importation of lady-birds, I have met with gratifying success in two attempts at exportation of our most valuable species, the "shining black lady-bird" (*Exochomus nigromaculatus*). This tiny insect preys to some extent on almost all of our scale insects and also on psyllids and aphides. It has done very creditable service about Capetown the last two seasons on the Norfolk Island pine coccus or araucaria scale (*Eriococcus araucariæ*), and is not infrequently reported to have temporarily cleared apple trees of woolly aphis. A number was collected during August and a sending made to both of the entomologists who were endeavouring to give us similar aid, Mr. E. E. Green, of Ceylon, Mr. W. W. Froggatt, of New South Wales. The in-

tention was to have sent the consignment for Ceylon in a wardian case on the deck of the vessel, but neither the ship's agents nor the officers of the vessel would accept the case for transport. The insects were consequently repacked and a smaller number, about fifty, sent by letter post. A wooden box, 3x8x10 inches inside, was used and the insects, all beetles to guard against the enclosure of parasitic enemies of the larvæ, were liberated within on joints of prickly pear plentifully stocked with cochineal insect. The joints were stood on edge in the box and supported in this position by wires passed through them and extending from one end of the box to the other. The spaces between the joints were loosely filled with dry moss, and after nailing down the cover, the box was wrapped in two thicknesses of heavy paper with closely folded seams to prevent the escape of either young scale insects or lady-bird larvæ. To be sure that the beetles would feed on the cochineal insect, only such as were collected on this food were enclosed. The package was sent by letter post instead of parcel post because letters are sent direct while parcels are sent by the way of England. "Cool chambers" are unknown conveniences on the steamers plying between Cape Town and Indian ports, so sending direct in this most approved way was out of the question. The collecting was done August 8th to the 10th, and the mail left Cape Town on August 13th. A quick passage was made, and on the 11th of the following month the package was delivered. The condition of the contents on arrival was described by Mr Green as follows :—

> "On first opening the box I was disappointed to find the top strewn with numerous dead beetles. However, I made a careful and minute examination of the whole contents, shredding the moss and examining each sprig with a magnifying glass, and was eventally rewarded by the discovery of five living beetles, four half grown larvæ, and half a dozen eggs. So far, I consider the experiment satisfactory, as showing that a certain number of living insects can survive the journey. I think the dead beetles must have lived their ordinary course of life and died. The larvæ are probably the result of a few eggs laid during the early period of incarceration." . . . . "There was no failure of food supply, large numbers of the cochineal insect were still alive and healthy, and I even secured a few living winged males. The

method of packing was most ingenious. Two only of the pieces of Opuntia had rotted."

An unavoidable change of food for the survivors had the effect of immediately reducing the little colony by a half. Three months later, however, Mr. Green wrote :—

"From the very few survivors (five only) of your sending of *Exochomus*, I have now some twenty to thirty healthy larvæ, almost full fed ; and some of the earlier arrivals have already completed their transformations. I never see the eggs of the beetles. They are apparently hidden amongst the dead scales. I therefore transfer all the dry leaves and rubbish to a separate jar and pick out the young larvæ as they appear. I generally find them crawling on the sides of the jar or on the muslin cover. Their favourite food is the egg masses of *Pulvinaria psidii* and they would prove most useful where this pest is prevalent. But I am now rearing them entirely upon *Lecanium viride*, as that is the pest they are intended to tackle here. They seem to thrive all right on it. I notice that they do not devour the insects completely. They sometimes bite a small hole in the back and suck out the contents through that aperture ; but generally they seem to extract the juices without making any visible hole. I supose they insert the points of their jaws and draw up the juices after the manner of the *Hemerobiidæ*."

It is intended during the coming winter to send reinforcements to the little colony in Ceylon, and in exchange I hope for sendings of *Chilocorus circumdatus* mentioned above. This account of the method of packing and its success, and Mr. Green's notes on the food preferences of the lady-bird, is given in detail chiefly for the information of other parties who are interested in the interchange of *Coccinellidæ* of different countries. It is within the scope of probability that our little lady-bird may become an insect of great value in Ceylon and Southern India, where widespread injury to vegetation is caused by *Lecanium viride*, the scale upon which Mr. Green is feeding his colony. It is not, however, a lady-bird which multiplies with anything like the rapidity shown by vedalia.

The sending to New South Wales was packed similarly to the Ceylon one, and like it was sent by letter post, it being inconvenient to have it go in the cool chamber as had

been proposed, because Sydney was not a port of call for the vessel. The success of this colony is thus told by Mr. Froggatt in a letter dated December 12th. :—

> "Yours of the 13th August with the packet of lady-birds arrived in due course, and the captives, which laid a good many eggs as soon as they were placed in a fresh box, were liberated on an apple tree covered with cheese cloth at the Hawkesbury Agricultural College. Last week I examined the tree and found a good many live beetles upon it, and signs that there had been many pupæ a few weeks before. Most of the woolly aphis was cleaned off and where there was a patch, I always found a beetle or two."

A box containing the same number of lady-birds forwarded to Ceylon and New South Wales and packed in all respects like these was retained in the Department. The temperature of the room in which it was kept was usually between 60° and 80° F. The contents were examined periodically from August 12th to October 9th to ascertain if any beetles survived. Few were seen on the latter date and hence the test was discontinued. The box was emptied, and seven of the fifty beetles found to be alive and active, with food in abundance. Another lot of the beetles was kept in a wire cage at the office with the same kind of food ; but none of these lived beyond the twentieth day. The temperature ranged fully five degrees higher in the office than where the box was kept, but this difference was not sufficient to account for the contrast in results. I infer that close confinement and total darkness are favourable conditions under which to send lady-birds on a long journey.

Other Scale Pest Checks.—Thus far no attempt has been made to introduce or to export other kinds of scale insect checks than lady-birds. Hymenopterous parasites, small wasps we might call them, play an important part in holding many scale insects in check, and it is undoubtedly to their services more than to the services of lady-birds that we enjoy relative immunity from the ravages of certain almost cosmopolitan scale insects. There are parasites which prey upon the red scale, but unfortunately none that are at all efficient have anywhere been discovered. One species that we have (*Aspidiotophagus citrinus*, on the authority of Dr. L. O. Howard) occasionally parasitizes fully fifty per cent., but it is often quite absent where the red scale is very plentiful, while it may be present among, and have destroyed ninety out of a hundred

white peach-scales (*Diaspis amygdali*) in a neighbouring peach orchard,

Lecanium oleæ Parasite.—But while I do not know from where we might import hymenopterous parasites to our material advantage, I incline to the opinion that South Africa has a parasitic wasp that would prove of considerable advantage to several countries for the control of the black scale (*Lecanium oleæ*). The black scale has not been reported as an orchard pest at this office once during the last three years, but it has been discovered at Capetown, Stellenbosch, Ceres, Oudtshoorn, Bedford, Port Elizabeth, East London, and other places, which shows it to be widespread in the Colony. More often than otherwise it has been found on indigenous vegetation, and several times on the veld at a distance from a road or habitation. Everywhere that it has been seen it has been found to be heavily parasitized, often every scale in many scores sheltering the parasite or bearing one or more of its exit marks. Nowhere does it appear to be abundant or even common. There is a possibility that the dryness of the South African climate deleteriously affects the species; but if this is the case, the question is opened of why it is not injuriously abundant in the comparatively humid coast districts. The suburbs of Capetown offer what seems to me ideal climatic conditions for its multiplication, but although once in a great while a single plant may be badly infested, the insect is here rather an uncommon species.

Fungus Checks of Scale Insects.—Fungi check the multiplication of insects to some extent. Two or three apparently parasitic ones have been noticed on scale insects in the Colony, but so far as has been observed these are not of much account in keeping their hosts in check. A certain scale-attacking species (*Sphærostilbe coccophila*) has, however, come into prominence in the southern United States this last two years by its almost complete destruction in limited localities of the notorious San José scale (*Aspidiotus perniciosus*). It is quite within the limits of possibility that this fungus may thrive at the expense of the red scale, which is a species of the same genus, and an attempt is being made to procure inoculative material for experiments. The wet winter and spring of the western province should furnish the essential condition of moisture but the relatively low temperature at these seasons may retard the development.

Strange Behaviour of Peach Scale in St. Helena.—It is possible that an efficient check for our white peach-scale (*Diaspis amygdali*) exists at St. Helena. The basis for this

conjecture is the recorded statement that a century ago the peach trees of the island suffered greatly from the attacks of a white scale insect which has since wholly disappeared from notice. Kirby and Spence, writing in 1815 (page 113, seventh edition), thus speak of the pest : " A coccus, as it should seem from the description, imported about thirty years ago from the Mauritius or else with the Constantia vine from the Cape of Good Hope, has destroyed nearly nine-tenths of the peach trees in the Island of St. Helena, where formerly they were so abundant, that, as in North America, the swine were fed with their fruit. Various means have been employed to destroy this plague, but hitherto without success." Reference is made to an older work, " Description of the Island of St. Helena," from which the information was probably derived. I have not had access to this second book, but in Melliss's " St Helena," published in 1875, is a long extract from it, in which the insect is described in such terms as to leave little doubt in my mind that it was the scale now known as *Diaspis amygdali.* The pest is said to settle on the trunk of the tree and to there form a white crust, a peculiarity that at once brings our white peach-scale to mind. Continuing, the old writer as quoted by Melliss, says : " It attacks other trees particularly the native gum-wood trees and the mulberry, but the trunk of the peach seems to be its favourite lodgment." Next to the peach, the mulberry suffers more than any of our other trees from the present-day scale. Melliss in his work, after relating what a severe pest the insect was formerly, goes on to state that the peach trees of his day enjoy immunity from the trouble, and expresses the belief that the pest had run its course and then naturally disappeared from the island, a fate which he intimates has also befallen other introduced insects, notably the death's head moth, *Acherontia atropos.* It seems to me, however, that some trace of the scale must still exist, and associated with it a powerful natural check. Through the kindness of friends, the subject has been brought to the notice of his Excellency, the Governor of the island, and he has written to say that diligent search will be made in the old gardens, and that should any insect answering the description be found, specimens will be forwarded to me. The result of the enquiries is awaited with much interest, but even should no occurrence of the insect be located, I would not think it conclusively shown that the insect is now extinct, for a few scales here and there would probably be overlooked by anyone not experienced in searching for this type of in-

sect. It may be remarked that *Diaspis amygdali* is known both at the Cape and Mauritius, the one or the other of which countries, as stated above, is credited with having furnished St. Helena with the peach scourge. It may have been here since the early days, but I know of no evidence whatever to show that it is native. An old volume records the occurrence of a white scale pest on peach in Mauritius sixty years ago, and it seems to me more likely that Mauritius or some oriental country furnished St. Helena the pest than this country. St. Helena was a port of call for ships returning from the Indies in by-gone days, and the occurrence of the insect in the far east is now established. But wherever the insect may have originated and whatever place may have been responsible for St. Helena's getting the pest, we know that *Diaspis amygdali* is now and has long been a destructive enemy to the peach at the Cape, and is now also highly injurious in Mauritius. It is also coming into prominence in most of the warmer countries and threatens to prove a cosmopolitan scale pest of considerable importance. It endures a very wide range of temperature and thrives not alone on peach, mulberry, and several other common fruits; but also on many ornamental and shade trees and shrubs, on a number of worthless weeds, particularly certain shrub-like perennial *Solanums*, and on some of the *Acacia* tribe that have been planted or sprung up along roads and in waste places in the Cape and other districts. More complaints regarding it are made to this office than about any other insect with the exception of red scale. If nothing of value is learned from the enquiries now being prosecuted at St. Helena, it may be well worth the while for our Government to send an expert to the island to thoroughly investigate the subject ; even should nothing further be learned of the scale, it is possible that the agent that suppressed it—perhaps now existing at the expense of other scale insects—may be discovered and brought to our country.

What checks Woolly Aphis in England ?—There is another instance of a possible opportunity of obtaining a natural check for an important pest to which I desire to draw notice when discussing this subject. The woolly aphis (*Schizoneura lanigera*) is a familiar insect to all our orchardists, and many consider it the most troublesome of the many pests with which they have to deal. It is also widespread in England, but all of the fruit growers of English training that I meet in the Colony say that at home it required little or no attention ; many, indeed, fail to remember it at all in their English

experience, while here it is a continual bane to them both in the nursery and orchard. Our climate is probably much more favourable to the multiplication of the species than is the climate of England, but it is highly probable that conditions other than climatic are responsible for the difference in the importance of the pest in the two countries. In an old, authoritative volume (Kirby & Spence's) is a passage regarding the occurrence of the insect in England, which reads : "But the insect which most injures our apple trees by drawing off their sap, and which has been known in this country only since the year 1787, is the apple aphis, called by some *Coccus*, and by others the *American blight*." . . . "Whatever its origin, it spread rapidly. At first it was confined to the vicinity of the metropolis, where it destroyed thousands of trees. But it has since found its way into other parts of the kingdom, particularly into the cider counties ; and in 1810, so many trees perished from it in Gloucestershire, that, if some mode of destroying it were not discovered, it was feared the making of cider must be abandoned." This is reliable evidence that for a number of years following its introduction, the woolly aphis seriously menaced the apple-growing industry even in England, and makes it apparent that the agencies now operative at mitigating its ravages are, at least, not *directly* climatic. There is nothing known, I believe, to gainsay that the check or checks are not such as might be successfully introduced into South Africa.

Notes and Studies on the Season's Pests.

Scale Insects.—The importance of scale insects as pests in South Africa, commented on in previous reports, continues to be shown by the number of complaints of their ravages. The red scale (*Aspidiotus aurantii* Mask.), the white peach-scale (*Diaspis amygdali* Tryon), the brown scale (*Lecanium hesperidum*, Linn.), the oleander scale (*Aspidiotus nerii* Bouche), the greedy scale (*Aspidiotus camelliæ* Sign.), the araucaria scale (*Eriococcus araucariæ* Mask.) and several species of mealy bugs (*Dactylopius*) have become standing subjects for complaint, especially among town and suburban gardeners. The araucaria scale was not noticed in Capetown itself until this year, but now it is seen to have a firm hold on many fine old trees. Mealy bugs were more than usually abundant and were frequently sent or brought to the office on guava, grape, granadilla and fig ; a few reports of their

presence on late-hanging oranges were also received. One species possibly *Dactylopius bromeliæ*, although our specimens do not fully accord with the description, is causing a little apprehension in the East London division by its attack on pine apples ; notes on it will probably be published in the *Agricultural Journal* within a few months. It is supposed to have been introduced from Natal. *Aspidiotus ficus* Riley, the red scale of Florida, and there a well-known citrus tree scale, has been received from Natal and Rhodesia. The purple scale (*Mytilaspis citricola*, Pack.) and the long scale (*Mytilaspis gloverii*, Pack.) have been found in several other orchards than those previously known to be infested, the former scale even in Worcester ; but though both species are bad enough pests in some gardens in the Cape division neither gives any indication of becoming nearly so destructive as the red scale. Extended mention of a species of *Prosopophora* (*Prosopophora prosopodis*, var. *mimosæ* Maskell), under the heading of "Thorn Tree Scale" was made in the *Agricultural Journal*. This interesting insect, which might be termed "beneficial," since it is destructive to the thorn tree in thickets, has since been discovered in small numbers near Grahamstown ; it is worthy of remark that every one of thirty or more specimens examined were parasitized. Notes on another scale insect, one of value because destructive to a veld-usurping, practically worthless shrub, have been written for the *Journal* under the heading "Harpuis Bush Scale ;" it is an undescribed species of *Asterolecanium*.

Orthezia insignis Douglas, a scale insect which has attracted attention by its destructiveness in American greenhouses and out-of-doors in a number of sub-tropical countries during the last decade, was found in February last at a florist's near Capetown. About one hundred and fifty large coleus and a smaller number of other plants were much infested. When apprised of the nature of his new pest and of the danger of its becoming an out-door pest of importance, the owner had the infested plants burned ; and he has since similarly disposed of every plant on which any of the species has appeared. All of the plant nurseries in the vicinity of Capetown were visited in quest of further occurrences, but, except at two private residences, no infested plants have since been discovered in this part of the country. However, occurrences have been located in gardens at Port Elizabeth and East London ; and the publication in the *Agricultural Journal* of an account of the insect

elicited the fact that it has been a garden pest in Natal for many years. Recently information has been received that the insect is also pestiferous in Reunion. How it reached Capetown remains to be explained. Like most scale insects it is prolific, and passes through several generations in the course of a season. Its food plants include many common ornamental shrubs and herbaceous plants, and withal, should the climate here prove favourable to it, it may become a very troublesome garden pest. In Ceylon it has spread from the Peradeniya gardens into a large tract of lantana scrub, and has there multiplied prodigiously. Some anxiety has been aroused by its inclusion of coffee and tea among its food plants.

Codling Moth.—The codling moth (*Carpocapsa pomonella*, Linn.) is—thanks to a long illustrated article in the *Agricultural Journal* and more so to correspondence in the daily press—now beginning to attract the attention it deserves among Western Province fruit growers. There is no longer any question that within a few years this insect will have become *the* difficulty in the profitable cultivation of apples and pears, that it now is in almost every other country, and the sooner our fruit growers realize this and act accordingly the less keenly will its ravages be felt by them. An illustrated placard describing the life stages of the insect and its method of working, detailing remedial and preventive measures, and recommending orchard treatment to prepare for its coming, is now being prepared at the instance of the Horticultural Board ; copies will be posted in the railway stations and post offices of the fruit districts. In addition to the localities heretofore recorded as infected, the insect is now known to occur in Constantia, Claremont, Capetown and Wellington.

Fruit Fly.—The wide range of fruits attacked by this notorious pest, *Ceratitis capitata*, Wied. (*citriperda* Macl.), has led to my substitution of the term "fruit fly" for "peach fly," the name by which it has been designated in previous reports. The season of 1897-1898 was a "maggot" season in both western and eastern districts, but the present season, 1898-1899, is marked by the welcome absence of the pest in all the early fruits and to a great extent in the later ones as well, even St. Helena peaches escaping in most localities east and west. There still remains much to be learned regarding the feeding and hibernation habits of the insect as well as the measures applicable for its suppression. A little progress has been made in these studies during the

year. To the long list of fruits known to be liable to attack, I have this year to add the Kei apple (*Aberia caffra*), passion flower (*Passiflora cærulea*) and *Solanum capsicastrum*. All of these fruits suffered considerably late in the fruit season of 1898. It is recorded that *Solanum nigrum* and *Solanum sodoniæum* are both attacked during the winter months in Western Australia; but although I have carefully watched these fruits for several seasons, I have failed to find any infested by the fruit fly even where they were growing close by, and ripening simultaneously with very badly infested peaches. *Solanum sodomæum* in common with the tomato when over-ripe and soft, however, often harbours the larvæ of a muscid fly almost as large as those of the fruit fly, and the former fruit is also commonly infested by a lepidopterous larva. The grape, especially the Hermitage variety, is frequently reported to be infested by the fruit fly, but I have thus far failed to secure confirmative evidence, such supposedly infested berries as have been sent to me containing only maggots of one of the vinegar flies (*Drosophilidæ*); competent observers have told me, however, that they are positive the fruit fly sometimes oviposits in the grape and I have no reason to doubt their assertion. Prickly pear fruit (*Opuntia tuna*) containing maggots which to all appearances were those of the pest fly were found last year in the Albany division, but unfortunately the insects failed to complete their transformations. Within a few weeks, however, and since this part of the report was prepared, I have reared a large number of the flies from this fruit collected in Capetown.

The success experienced within the two previous years in protecting fruit by means of netting used to enclose the trees, led to my recommending the Board of Horticulture to advertise and generally introduce this measure of prevention by importing a cheap cotton netting for disposal at cost among the fruit growers. The Board approving, the Department of Agriculture was requested to conduct the business. Applications for the netting were solicited in the *Agricultural Journal* and an order for about 20,000 yards thus secured. This amount was duly imported and distributed. The selling price was made 5s. 6d. per piece of 30 yards. In width, the netting measures from 68 to 70 inches. There are ten threads to the linear inch and while the fruit fly can force its way through the mesh, it rarely if ever will do so to get to fruit on a tree, although it will push its way through and escape if a single thickness of the netting is used to cover the open mouth of a jar in which it is confined. Safety pins

have been found more satisfactory for keeping the nets in place on the trees than ordinary pins or sewing, and even the cheapest kinds—those costing only eighteen pence to two shillings a gross—are plenty good enough and will doubtless remain serviceable for several seasons. After spreading the net over the tree the four corners are drawn beneath and the alternate ones tied together, thus leaving the net open only in four long slits, the edges of which may be easily brought together and rolled to hold the pins. By covering a few trees an intelligent workman will have acquired sufficient experience to guide him in cutting netting for further trees without waste of the material. On well-shaped trees which contain no dead tips, the nets, when properly put on and neither too tightly nor too loosely, suffer little injury and should be good for one use each season for at least three years. Several parties used their netting this season to protect successively maturing fruits from birds and insects—peaches in January and figs, grapes and other fruits in February and March, and found their investment highly remunerative.

To prevent any misunderstanding, however, I reiterate what I have stated elsewhere, that this netting measure for staying the ravages of the fruit fly is not recommended for extensive orchards. Where fruit is grown on a large scale, I am firmly of the opinion that reliance may safely be placed on the daily gathering of the windfalls and the suppression of all the wild and ornamental fruits in which the pest may breed. The co-operation of neighbours in the conduct of such a campaign is extremely desirable, but if the measures are thoroughly carried out from the very *beginning* of the season gratifying results will be the reward in every truly extensive orchard, despite negligence in surrounding gardens and orchards ; and no more effective persuasion than this may be brought to bear on the careless neighbours to secure their conversion to the adoption of the measures.

A number of experiments were conducted during the last season to determine the value of odours in deterring oviposition. Asafœtida displayed on cloths and wood-wool failed to keep the flies away from the trees. The stench from this substance rapidly lessened, but where much was used was distinctly in evidence for over a fortnight ; should the measure have been shown a success in preventing the attack, I would not consider it one worthy of recommendation, for the case would truly be one in which the remedy is

worse than the disease. A dilute solution of a compound made by boiling Stockholm tar with caustic soda sprayed over the foliage and fruit, stained the latter to so great a degree that even if the spray ensured the absence of maggots it would fail to commend itself to fruit growers ; peaches and nectarines reeking with the odour of tar would find as few purchasers, in my estimation, as similar fruit in part maggot-infested. This measure has been recommended in other parts of the world for the protection of fruit from flies allied to our destructive species, and hence my trials with it. The effect of the spray on the flies was not conclusively demonstrated, little of the fruit on the check trees, unfortunately for the experiment, becoming "blown" by the pest ; yet some fruit stained by the spray and on which the odour of tar was still clearly perceptible was found to be blown. Fruit on trees covered with inch mesh fish netting which had been soaked immediately prior to application in an infusion of blue-gum foliage, became as badly attacked as the fruit on check trees, as did also fruit of trees under similar netting which had been steeped in cresoline for six hours. The eucalyptus odour passed away in a few days, but the cresoline was faintly apparent for over two weeks. Two trees were sprayed with quassia and syrup in a water solution. This spray left little or no odour, but its persistency was unpleasantly betrayed when the tongue was applied to the surface of the fruit. No fruit on the sprayed trees nor on their checks became maggotty ; but the indifference of the flies to the bitter principle of quassia was indicated most decisively by cage experiments conducted at the office. A large number were fed for four days on a concentrated mixture of sugar and quassia infusion. Every fly fed greedily, but not a single death followed the orgies. The experiment was thrice repeated, and left no doubt on the inefficacy of this oft-suggested mixture as a destroyer or deterrent for the fruit fly.

Calandra of the Vine.—Our knowledge of the calandra (*Phlyctinus callosus* Bohem.) of Western Province vineyards has increased little during the year. Fresh gas-lime dug into the soil at the rate of ten bags to a thousand sticks in July, failed to prevent the appearance of the adult beetles when their season came around in November. The remarkable success obtained from an application of lime in 1893 by Mr. J. P. de Waal remains unexplained*, although

* Report of Officer in Charge, Government Wine Farm, for 1894.

presumably due to the caustic effects of the lime on young larvæ. I apprehend further that the success of lime applications depends upon several more or less uncertain factors, one of which is, doubtless, the purity and freshly-slaked condition of the lime, and another, perhaps, the occurrence of soaking rains within a short time. I think it would be well for vine growers who are interested in the subject to experiment with lime and make public their results. The application might be made at the rate used by Mr. de Waal—ten bags to one thousand sticks—and at fortnightly intervals from the middle of May to the middle of August to successive small sections of the worst infested portions of the vineyards. Untreated sections should intervene in order that direct comparison of the degree of infestation may be made the following season, and the date at which rains follow the application should be noted in each case to determine if they affect the results. I had hoped to get such a series of experiments conducted under my supervision, but have not for one reason or another been successful in so doing, and thus am led to make the above suggestion.

Insects closely related and of similar habits to the calandra are vineyard pests in most vine-growing countries but, so far as one may judge from writings, the evil is rarely as aggravated as in the Constantia area of this Colony. Foreign writers recommend a system of trapping the beetles similar to that in vogue in this country, and in a few French works is a supplementary suggestion to employ carbon bisulphide against the grub stage in the soil. The treatment of vineyards with bisulphide is such an expensive undertaking that I am inclined to consider this measure solely as a "book remedy;" still it might prove economical in limited areas where the insect is extraordinarily abundant and the vines of great value.

With the object of rendering the "pockets" of grape leaves laid as traps of greater effectiveness for their purpose, Mr. de Waal has had the rough bark removed from the sticks over a portion of his vineyards. Gloves composed of steel rings linked together were employed to rub off the bark, and the operations proved less tedious than one might expect at first thought. He tells me that the measure appears to make a greater proportion of the beetles seek the treacherous shelter of the pockets, and if his present judgment is confirmed by next season's experience other growers may profitably adopt his innovation as an addition to their present combative methods. The removal of the

rough bark deprives the beetles of their otherwise most secure winter quarters, and thus may also prove of much value ; similarly it exposes hibernating mealy bugs more effectively to their enemies, and mealy bugs seem on the increase in a number of the Constantia vineyards.

Outside of the Constantia area, one now hears most of the calandra in young vineyards of grafted vines, a circumstance due in part to many of the young vineyards being planted on the sites of old ones, and in part to the value of grafted stocks compared with simple cuttings. The calandra is an indigenous insect and not uncommon on many veld bushes and, therefore, it may infest vines that are planted on newly broken veld even before these start into growth. I hope some day to discuss the calandra in detail, but it may not be out of place to here refer to the chief points of its life history. The beetle itself is long lived ; many individuals survive the winter in the shelter of the rough bark of the vine sticks or in rubbish among the vines, and in the spring do much damage by eating the expanding buds. The new brood emerges from the soil about the first of November, and may be distinguished from the survivors of the preceding brood by the lighter colour and softer tegument. Mating of the sexes has been observed in January, but does not become general until early March. Eggs laid by captive beetles only have been observed. These were obtained in numbers during the third week of March ; most were deposited on pieces of root buried in the soil, but others were laid loose on the surface. The number of eggs laid is unknown, but as high as one hundred and fifteen have been counted in the ovaries. Close search is required to find the larva in the ground, even where it is abundant, until it is nearly full-grown. It is a broad, thick-set, whitish grub, and when ready to pupate is about one-third of an inch in length. None have been observed before July 15th, at which time some are already half-grown. Pupæ have been found in early September, and are common by the first of the following month ; they are formed in soft earthen cells, and generally within four or five inches of the surface.

The calandra is by no means a pest of the vineyard alone. Some fruit growers are greatly troubled with it both in deciduous and citrus orchards, and gardeners in parts of the Cape district have no greater pest among their ornamental plants. I have collected it from indigenous plants high on the slopes of Table Mountain, but have never seen it nearly so common on the veld as it is in cultivated lands. Doubt-

less the loose condition of the soil in the latter situation favours much the propagation of the insect ; in other words one of the most important natural checks to keep the insect in subjection is almost absent in the vineyard, orchard and garden.

Ticks.—Measures for the suppression of the skin parasites of domestic animals are subjects for the veterinarian, but the determination of the species and the elucidation of the life histories of these belongs rather to the sphere of the entomologist. The rapidly increasing importance of ticks led me to give them some attention during the past twelve months. Through my own exertions and with the valuable assistance of the Colonial Veterinary Surgeon, Dr. D. Hutcheon, the important species have been collected from stock in various sections of the Colony. As time permits, the identity of these will be determined, and I hope to gradually solve the question of the habits of the more important species both on and off their hosts. Some progress has been made, but the researches are proving both slow and difficult. The identity of the so-called "bont" tick with specimens collected in South Africa over half a century ago, and named *Amblyomma hebræum* Koch, has been confirmed by comparison with the original description and drawing. This tick gives rise to far more complaints than all the other species combined, and if not extending its area of occurrence it is at least rapidly increasing in numbers in many sections. It appears to be practically confined to the south-eastern districts. Of its life history little has yet been learned. The adult female drops to the ground and partially secretes herself in soil or rubbish. We have determined that she may begin to oviposit within two weeks in summer or delay as long as ten weeks in winter, that the complement of eggs may be as many as 17,000, and that the oviposition of these may in winter occupy a period of nine weeks. The eggs laid in midwinter may not hatch until after the new year. That such a long period of incubation is not exceptional is shown by the record of several ticks. Three collected on May 13th, just after they had dropped of their own accord from cattle, began to lay July 22nd-26th and finished laying about the middle of September. No change was noted in the eggs until December 10th, when signs of development were apparent, and on January 23rd the first egg hatched ; several other batches of eggs laid between August 23rd and October 26th by ticks received during June, began to hatch on January 9th. In the summer the incubation period is very much less. Eggs

laid by one female from January 26th to the 28th began to hatch April 17th, and a number laid by another female on January 26th hatched on April 13th. All our attempts thus far at rearing the ticks have failed, and it is a curious fact that every one of many hundreds of specimens of this species received at the office through the kindness of veterinary surgeons and farmer friends is adult.

Next to the bont, a species which has been called the "bont-leg" tick appears to give the greatest trouble. This species is confused with the bont by many farmers. The legs of both are banded and thus both are covered by the Dutch term "bont pooten" (speckled legged) but as the dorsum (back) of the male of the first species is piebald as well as its legs, the simple term "bont" may well be used to designate it. The two species are about the same shape and size, but the colours are dissimilar. The males are most readily distinguished, the male of the bont is bluish-yellow above with black markings, while that of the bont-leg is uniformly dark brown. The bont-leg occurs all over the Colony, but most complaints of it have come from the midland districts, where it is said to trouble small stock and ostriches as well as cattle and horses, and to be particularly abundant in the spring months. Like the bont, the bont-leg is partial to the under parts of the body. It is a species of *Hyalomma* and is possibly identical with *Hyalomma ægyptium*, Audouin. [The *Acarus ægyptius* of Linnæus]. Its complement of eggs is seemingly quite as large as that of the former species. In cases under observation eggs laid December 11th by ticks received about ten days before, began to hatch February 6th. Oviposition continued fourteen days. Young of this species hatched in the latter part of January and placed in a cork-stoppered glass tube without moisture are alive at the time of writing, May 8th.

A third common species is the red tick, and this one, Mr. Fuller, the Assistant Entomologist, has succeeded in connecting with *Rhipicephalus evertsi* Neumann. It is a widely distributed species, and is probably to be found in every district of the Colony. The anus and adjacent parts are most subjected to its attack.

The commonest of all our ticks is the one popularly designated "blue" or "blood" tick, a small species becoming at the most a half-inch in length by a third in width and quite as rotund as a pea-bean. It is less active than the other species and less particular where it settles, it often being found even on the back in large numbers. It closely resem-

(*Ixodes* or *Boophilus bovis*) and the Australian cattle tick, bles an American species, *Rhipicephalus annulatus*, Say, *R. australis* Fuller, both of which are associated with the transmission of the disease red-water. Until recently we supposed all three species to be one and the same, but by careful study Mr. Fuller has satisfactorily shown them to be distinct. Ours he connects with *Rhipicephalus decoloratus* Koch. The blue tick is widely pravelent in the Colony, and is most abundant near the coast. Owing, probably to the abundance of the larger and far more injurious bont tick, little thought is given to it in the eastern sections. In the south and west it occasions greater anxiety, and on some farms it is said to sometimes become so exceedingly abundant that it seriously interferes with the rearing of calves. 1893 is mentioned as a tick year in parts of Malmesbury. Whether a transmitter of red-water or not, the species occurs in great numbers in many districts where the disease is unknown.

Thus far we have only attempted to rear the bont and bont-leg ticks. Young of the latter have been secured in thousands and placed on young cattle isolated in a paddock near Capetown, but not a single individual has taken hold. Several hundreds were liberated on guinea pigs with like lack of success ; and then, in desperation, hundreds were placed on our own bodies. All, however, disappeared after a few days without any attempt to establish themselves. When placed under watch glasses, secured to the skin by sticking plaster equal discouragement followed, for all died, apparently from the heat and perspiration. During the present year, however, renewed attempts will be made, and when the next report is submitted I hope to have data on the life histories.

The fowl tick has been given some attention. During the year it has been received with complaints of its injuries to fowls from Sea Point, Grahamstown, Graaff-Reinet and Uitenhage. Some farmers call it "wand luis" (wall bug) and others "tampan." I have compared it with specimens of fowl ticks received from India, Australia, and America, and am satisfied that the specimens from all four countries are of the same species of *Argas*. Correspondence with Mr. A. D. Michael, the English authority on ticks, has confirmed this view, and Mr. Michael further remarks that the species is probably identical with *Argas reflexus*, Fab. of Europe ! This tick possesses greater vitality than any other creature that I have attempted to kill with insecticides. Two

hours' exposure to hydrocyanic acid gas when one ounce was used to 150 cubic feet of space scarcely served to decrease its activity, and many individuals survived some days after treatment with paraffine and other oils. Confinement for three months in a small box nearly filled with flowers of sulphur had no appreciable effect on it. Extended notes on the species will probably appear in the *Agricultural Journal*. A man-attacking tick, also called "tampan" and superficially somewhat resembling the fowl tick has been received during the year from the Transvaal, Bechuanaland, and northern parts of the Colony. It has been provisionally determined *Onithodorus savignyi*, Audouin. Another species of the same genus, one found in penguins' nests on Possession Island, has been added to our collection by Mr. W. H. Tooke.

Woolly Aphis.—The woolly aphis of the apple (*Schizoneura lanigera*, Hausm.) seemed to find the 1898 conditions unusually favourable all over the Colony ; at least, complaints of its greater troublesomeness came from widely separated sections. The use of resistant varieties for stocks to prevent infestation of the roots is increasing, but not as rapidly as is desirable. Two cases of pear trees becoming injuriously affected have been reported, and there seems no reason to doubt the identity of the insect in either case ; malformations in the growth quite as pronounced and as characteristic as those formed on apple were produced. Fruit growers might profitably raise a little tobacco for use in combating the woolly aphis ; an infusion of the dried leaves and stems is easily prepared and is highly efficacious against the aphides on the parts above ground, while in the form of dust incorporated with the soil several of our fruit growers have found it satisfactory in subduing those on the roots. Winged individuals of the woolly aphis have only been noticed during the fall of the year, March being the month for their general appearance. Eggs have not been observed, and whether they occur or not, reproduction without this stage takes place throughout the winter in our south-western districts.

Plant Bugs.—The Bagrada bug (*Bagrada hilaris*, Burm.) ranked as one of the chief garden pests of the year, and so many enquiries concerning it were received that it was made the subject of an illustrated notice in the *Agricultural Journal*. Cruciferous plants were the chief sufferers, but potatoes, tomatoes, and even maize were sometimes reported to be destroyed. *Antestia variegata*, Thunb., has the pernicious habit of puncturing fruit, and is a very common all-the-year-

round pest about Capetown. Part of the injury to peaches and other soft fruits attributed to the fruit fly is due to this insect, decay frequently starting at the punctures, and the fruit prematurely falling to the ground. A drop or a string of gum protruding from the wound often indicates the work of the pest on green peaches, and thus early serves to confuse its attack with that of the fruit fly, a similar exudation often following the puncture by the latter insect. No fruit is more subject to attack than the apple, but the injury to it seldom results in more than a slight surface blemish.

Holopterna valga, Linn., an insect to which the term "twig wilter" might, with propriety, be applied, was very abundant during the spring months about Capetown, and was the subject of a number of personal enquiries at the office by parties whose gardens were being ravaged. I believe it to be a common insect every year in most sections of the Colony. It is the large, dark brown bug, with long, bi-coloured antennæ and long curved hind legs, that punctures the tender shoots of oranges, roses, and many other trees and plants and, by extracting the sap, causes the growth beyond the point of attack to wilt and often to perish. Many specimens of the creature measure over an inch in length and nearly a fourth inch in width. The sides of the body are almost parallel, but in front of the scutellum (near the head) they extend upward and outward, and then abruptly inward and downward, thus forming a pair of triangular projections ; one might describe these projections as shoulders. Perhaps what characterizes the insect more than anything else to most persons brought in contact with it, is the volume and nauseating property of the odour with which it surrounds itself when disturbed. The odour arises from a fluid secreted by glands opening on the underside of the body. Nearly all bugs are capable of creating an abominable stench, including all that are discussed in these paragraphs, but it seems to me that this species has the power developed to a more than ordinarily offensive degree. The eggs of the plant wilter—to adopt the name which I have suggested—are laid in single rows of ten or thereabouts, generally on a twig or the petiole of a leaf. They are relatively large eggs, brown in colour, and placed end to end ; the row might be mistaken for a short string of beads. The parent insect probably has few enemies other than man, but the egg stage is much subject to the attack of a wasp parasite.

A melon-attacking bug (*Aspongopus nubilus*, Burm.) was much complained of early in the year by several Bechuanaland and Free State farmers. This is a brown and black, heavy bodied bug, seven-tenths of an inch in length and four-tenths in width. It is said to appear on the lands early in the spring, and sometimes in such numbers that every melon and pumpkin vine succumbs to its attack. All plant bugs are difficult insects to contend against. There is probably no more practical remedy for any of the species mentioned than hand collecting ; I do not mean actual hand picking, but rather shaking or knocking the creatures into a pan from which they cannot escape, or in the case of the two large species on to the ground where they may be crushed underfoot. The remedy should be applied as soon as the first of the insects make their appearance in the spring, with the object of getting as many as possible of the overwintered gravid females destroyed before they have laid their eggs. Lands which have been badly infested by the bagrada bug or the melon bug should be kept free of litter in which the insects might find shelter and food for the winter, and all valueless, badly infested plants should be burned.

Miscellaneous Lepidopterous pests.—Caterpillars do not figure prominently among the complaints of insect ravages made to the Department. There are a number of kinds, many of them imported insects, which every year, however, cause considerable damage to crops. The cabbage plutella (*Plutella cruciferarum* Zell.), the "cabbage moth" of many gardeners, was very prevalent in 1898 ; many cabbage fields in the Cape district appeared almost white from a distance owing to its attack. The potato tuber moth (*Gelechia solanella* Boisd.) is common throughout most if not all of the potato-growing sections of the Colony, and if it were not that the crop is marketed and consumed early, it is probable that this insect would be responsible for heavy losses. Capetown, and to a lesser extent our other chief ports as well, it may be remarked, are supplied with imported potatoes for several months of the year. As is quite natural in the case of pests known for a long period and always more or less troublesome, it is not often that enquiries are made relative to the tuber moth ; but two were received during all of last year. Imported potatoes are nearly always free of the pest. Three consignments from Lisbon, Portugal, aggregating three hundred and thirty cases, which arrived at Capetown in October, were an unfortunate exception and were confiscated. Thousands of moths flew up from the hold of the vessel when

the hatches were raised, and on examination, the tubers were found to be in a much infested state. Cut-worms or mest-wurmen of several undetermined species formed the basis of a few enquiries, and were made the subject of an article in the *Agricultural Journal.* The tomato worm (*Heliothis armiger*, Hubn.) seems to be always an affliction to early tomatoes, and was sent in by two parties in early November with the mention that it was injuring green peaches and plums. However, its injuries to fruit was much less than in the season of 1897-1898, when a large proportion of the fruit in many Cape district orchards were eaten into ; little of this fruit proved a total loss for the injured parts healed over, leaving only a deep scar. This caterpillar is also well-known for its attack to the cobs of green mealies (Indian corn) and, late in their seasons, it eats its way into the pods of beans and peas. There is another noctuid caterpillar which shares in the attack to beans and peas, and I believe this to be the same one which proves troublesome by devouring the buds and young foliage of pip and stone-fruit trees early in the season. The Karroo caterpillar (rupsen or rispers) (*Loxostege frustalis*, Zell.) appears to be less destructive than for many years back, a circumstance, perhaps, due to the prolonged drought. This pest is said to appear in myriads a few weeks after summer rains, and to quickly change the green of the Karroo veld to a desolate brown by its ravages to the Karroo bush (*Pentzia virgata*, Less.). An investigation to ascertain the life history and habits of the insect was promised the Zwart Ruggen's Farmers' Association two years ago, but the promise still remains unredeemed as none of the members of the association have reported a re-appearance of the insect in numbers. The adult insects have been collected near the railway line as far west as Grootfontein, and as far north as the Orange River.

Antheræa tyrrhea, Cram., a large, stout-bodied, black and white, almost hairless caterpillar, has been becoming increasingly abundant on the veld near Wellington for three or four years. It feeds principally upon what is locally called "crow-berry bush," but attacks several other plants. On a few farms it has proved an annoyance by stripping one of the wattles (*Acacia saligna*) near the homesteads, and when wandering about in search of favourable soil in which to pupate, by staining linen spread out to bleach. The eggs are laid during April in conspicuous, ball-like clusters, which are attached to a twig of a food plant. The caterpillars are abundant in July and August, and many may be found up

to the middle of September. They are gregarious when young, but scatter when they approach maturity. The largest when full grown measure between four and five inches in length and nearly two inches in circumference. They pupate in the ground without a cocoon or cell. This species occurs in the eastern part of the Colony as well as the western, and full grown caterpillars were noticed to be abundant on thorn trees (*Acacia horrida*) at Grahamstown in mid-January of the present year. Its appearance in the east during the summer, while in the west it is a winter insect, is probably due to the difference in the season for rains, in the respective sections. This occurrence in opposite seasons has been observed in the case of a related species, *Antheræa cytherea*, Fab. The caterpillar of the insect insect resembles the former in most respects but that of colour, and the moths, also, are much alike. The caterpillar is a showy creature, resplendent with pale scale-like spots on a black background. and banded with red between the segments. Its food plants are many and include several, if not all, of the pines, the cypress, and the pepper tree (*Schinus molle*). Three years ago it was reported to be doing considerable damage in pine plantations in the Cape district, and for the past year or two pine plantations along the eastern frontier have, I am told, suffered severely. In the East, oak, apple, rose and wattle (*Acacia mollissima*) are said to be included in the food plants. Eggs in small clusters attached to pine needles have been found at Mowbray in early July, and caterpillars were found on the same trees from then until November. Pupation takes place on or in the ground. The moths have been seen on the wing in the same locality in April. Caterpillars bearing the cocoon of a wasp parasite were sent to me three years ago both from Messrs. W. M. Brown of the Uitvlugt government pine plantation at Mowbray, and T. R. Sim of the Fort Cunynghame government plantations.

An outbreak of a caterpillar suspected of being the notorious gypsy moth (*Porthetria dispar*, Linn.) was reported at Sea Point in early August. On investigation the ravaging insect was found to be the common *Dendrolimus capensis*, Linn., and the ravages confined to a few large *Acacia saligna* trees which had been stripped almost bare of foliage. This is the insect sometimes so abundant on the oaks in Government Avenue, Cape Town. It is a rather slim hairy caterpillar three to four inches in length when full-grown. A broad stripe, brown on the thoracic joints and black behind, extends the length of the body along the middle of the back.

From this stripe a purple tuft of soft hair extends over the head, brown tufts of short spinous hair project from the thoracic joints, and black tufts from the other joints. Outside of the stripe is a light-coloured relatively hairless area, and below this extends outward a fringe of long, soft, reddish-brown hair. Caterpillars from Sea Point spun cocoons among the leaves of their food plant in mid-September, and moths emerged from these cocoons two months later. An undetermined bag-worm (Family *Psychidæ*) was received in the first week of August from a Worcester vine-grower, with the information that it was becoming a pest in his vineyards. He had adopted hand picking as a remedy, and at the time of writing his boys were collecting over six quarts a day. The insect is also known at Paarl and Wellington in vineyards. *Acræa horta*, Linn., the most common butterfly in the vicinity of Capetown, is complained of by the Conservator of Forests as so abundant at Tokai forest nurseries that it seriously interferes with the propagation of *Kiggelaria africana* ; hardly are the young trees started than they become attacked by the black, spiny caterpillars.

A caterpillar pest of a more destructive type is the apple and quince borer. This insect, Mr. Peringuey of the South African Museum tells me, is *Cossus tristis* Drury, and in the "Transactions of the South African Philosophical Society," volume iv., part 1, page 24, he mentions that it attacks *Buddleia sp.* ? I have seen it only in apple, quince and pear, commonly in the first two but rarely in the last. The young feed in the wood just beneath the bark, as a rule, and sometimes destroy a branch by girdling it. The older larvæ tunnel the middle of the wood. The castings are ejected from the entrance to the burrow and furnish an index to the attack, a mass of them almost invariably clinging to the bark. Many caterpillars may occupy the same burrow, but each one has its own outlet to the surface through which it is to escape as the moth. The outlet is usually if not always above the pupa. Nineteen small caterpillars have been removed from one burrow near the surface, and as many as twenty full grown ones have been taken from a piece of apple branch twelve inches in length and one and one-half in diameter. I do not know how long the larvæ take to mature. Very small ones have several times been found in the same branch as half and full-grown ones, which, at least, indicates that different broods overlap. Pupæ have been found in July, but are more abundant two months later, and all of the score or more of moths which I have obtained emerged

between the middle of September and the first of November. One female reared in captivity laid one hundred and eighty-five eggs. Most of them were laid on the smooth bark, but a few were placed in a break ; they were not regularly placed but simply strewn about, sometimes thirty or more in a single patch in which they lay two or three deep. Forks of the branches are favourite places at which to start the attack. The mature caterpillar measures nearly two inches in length. It is sometimes wholly flesh coloured, but most specimens are prettily mottled with red. In well-kept orchards the castings ejected by the caterpillars are noticed, and the evil ended by aid of the knife before the injuries are far progressed. But in poorly kept orchards, especially among unpruned trees, and in quince hedges, the castings are usually unnoticed or unheeded and the pest breeds unchecked. Some farmers have told me that it ruined so many of their trees that they had ceased to pay attention to apples. Yet by timely exertion any tree may be preserved ; even after the caterpillars have begun to tunnel in the heart-wood they may be easily destroyed either by the insertion of a pointed wire or the injection of a little paraffine. I have not met with the pest away from the Western Province. It is common in the Stellenbosch and Paarl districts and, at least, within the town at Worcester. I did not know it to occur in Cape-town until the past year. In March last I found it at Sea Point and in the Kloof in quince hedges, and within a few months in a quince hedge at Rosebank. Cape district fruit growers should be on the look-out for it and keep it in close subjection on their grounds from its first appearance. A somewhat similar but smaller lepidopterous larva is destructive to osier and willow in widely separated sections of the Colony. I remember to have observed its work in Oudtshoorn, Seymour and New Bethesda (Graaff-Reinet).

Miscellaneous Coleopterous Pests.—The keever beetle, *Heteronychus arator*, Fab., was several times reported to have seriously injured newly set fruit trees by gnawing the bark just beneath the surface, and to have quite destroyed one year old vines by similar work. These complaints have come from Stellenbosch, Paarl and Worcester. In the eastern parts of the Colony, this beetle figures as a grain and mealie pest and as such was described by Miss Ormerod in her " South African Insects," and by the late S. D. Bairstow in the *Agricultural Journal* during 1896. I have not seen the larva. *Adoretus capicola*, Burm., related to the last and of the same size and general form, but dull brownish-grey

with white dashes in colour instead of glistening black, was the subject of enquiries from Kimberley, Barkly West and Potchefstroom, S.A.R., in October and November. It is reported that the beetles lie hidden in the soil during the day and come out at night, and that they do considerable damage to the foliage and fruit of the grape. Hand gathering the beetles during the day seems to be the most successful remedy thus far tried. Perhaps the keeping of turkeys in the vineyards would prove as effective and much more economical. Spraying with Paris green is said to be of little value.

Malacosoma borrei Allard (determined at South African Museum) was mentioned as very troublesome to young vines by a few Worcester and Stellenbosch growers. This is a small chrysomelid beetle, with green wing covers and yellow thorax. In vineyards it is generally found only near the borders, and the presence of wild growth round about is probably accountable for it. Jarring them into a tin containing a little paraffine when they are congregated on the under side of the leaves in the early morning is probably the most economical method of disposing of them. A suspected case of phylloxera in a Robertson vineyard turned out on personal investigation, in January, to be the failure of a number of vine sticks through the attacks of an otiorhynchid beetle. The injury was intensified by drought and hot winds. The beetle has not been determined but it resembles the " black calandra " (*Eremuns atratus*, Sparrnes) of Cape district orchards.

The blaauw biesje (*Haltica indigacea* Illig.) and the odontionopa beetle (*Odontionopa sericea*, Gyll.) were both in evidence in many Western Province orchards during the spring months, but neither of them, to me, appeared to be as abundant as the previous year. They were made the subject of an illustrated article in the *Agricultural Journal*. I have been unable to find the early stages of the odontionopa. There seems to be but one brood. The beetles appear in great numbers from late August to late September, the variation being with the season and locality, and, as a rule, appear on the same trees for several successive seasons. Frequently the trees in one part of an orchard are attacked severely, while trees of the same variety a short distance away escape almost entirely. Gradually the numbers of the beetles decrease and few are about by mid-summer. Some native shrubs on the slopes of Table Mountain suffer quite as much as orchard trees and garden plants. Jarring the beetles from the trees in the cool of the day into

pans or cloths seems the most practicable remedial measure. A few small plum trees were covered over with mosquito netting, such as is recommended on another page to protect fruit from the fruit fly, to determine if this would check the mischief, but the beetles crawled through the meshes and did almost as much damage to these trees as to surrounding uncovered ones. The damage is chiefly to the foliage, which is just unfolding when the attack begins, but often the base of fruit buds is attacked, and thus the twigs so weakened that they soon break in the wind. The blaauw biesje has probably a number of broods during the season. The beetles come out of the winter quarters in August, and by the end of the month their yellow eggs may be found in clusters on the underside of the leaves of dock (*Rumex obtusifolia*) and allied plants in sheltered situations. Early in October the beetles of the next brood were out in force in the suburbs of Capetown last year. It is the second brood which attracts the attention of fruit growers, for when it appears fruit trees are in leaf and tempt the swarming beetles. The black, somewhat greasy larvæ were exceedingly plentiful during the middle of October, and I carried a number to the office in order to determine the duration of the pupal stage. Almost every one, however, succumbed to a wasp parasite. The same results attended a second trial, and it was then apparent why this insect is abundant only in the spring : the parasite overpowers it in the second brood. The remedy for the blaauw biesje is to destroy its food plants—dock or tong blaar, sorrel and related weeds—early in the spring where they occur in and about the orchards.

The melon epilachna (*Epilachna chrysomelina*, Fab.), a large round-backed, black-spotted yellow, plant-feeding lady-bird, was as usual the burden of a few complaints from Karroo districts. It is there a pest of some importance to melons, pumpkins and other cucurbs. The insect occurs west to Capetown, but here occasions no complaint ; in the Worcester division, however, it is said to sometimes become very numerous among potatoes. The spiny larva or grub eats the foliage as does the parent beetle. The grass epilachna (*Epilachna similis*, Thunb.), a much smaller species than the last-mentioned, flat for its kind, and black-spotted on a sordid red background, was reported as injurious in several parts of the Western Province, but chiefly in suburban gardens. Both the beetle and its black larvæ are very common on grass and mealies (Indian corn) during the spring. They eat the epidermis of the leaves, and the underlying

tissue dries out in consequence. All stages of the insect, egg, grub, pupa, and adult, are common on the food plants in late September, but the damage is chiefly done six or eight weeks later.

Mylabris beetles (*Mylabris* spp.) are garden pests all over the Colony and several species are sent to the office every year. They are all long, black, slim-necked beetles broadly banded with yellow, and they feed chiefly on blossoms. Their levies are principally on small fruit, vegetable and flower gardens. Nowhere are their ravages more pronounced than in the homestead gardens on lonely grazing farms, especially on the Karroo ; doubtless the beetles bred on the veld flock to these miniature oases from considerable distances. Hand picking in the cool of the day seems to be the most practicable remedy. Allied insects in Amercia are known to prey on locust eggs when in the larval stage, and on the authority of Mr. Peringuey (*Agricultural Journal*, vol. vi., page 84) the larvæ of our species are similarly beneficial. Mayhap the present abundance of locusts in some districts is correlated with the coincident abundance of *Mylabridæ*.

Among other beetles which figured in complaints during the year are *Monochelus natalensis* Perin. and *M. calcaratus*, Burm., reported to shred the foliage of wattle (*Acacia mollissima*), oak, apple and other trees in frontier districts ; a species of *Formicomus* said to eat off all kinds of garden vegetables at Upington ; *Aulacophora vinula* Erichs. from Stellenbosch, a melon-vine feeder ; *Bostrychus cornutus* Oliv., a ptinid borer in bamboo at Oudtshoorn ; and *Phryneta spinator*, Fab., a large, long-horned beetle from southern districts and the Hex River valley, which eats the bark from young wood of fig and pear.

Other Miscellaneous Pests.—The pear leaf blister mite (*Phytoptus pyri*, Scheuten) was observed to be unusually prevalent in Western Province nurseries during the latter part of the year, and is much more common in orchards now than it was three years ago. Although an undesirable introduction and one against which orchardists might wisely seek to guard their trees, I cannot say I often find it in sufficient abundance on well-established orchard trees to do serious injury.—The bryobia mite (*Bryobia pratensis* Garman), now known to be wide-spread in South Africa, has been complained of only from the Oudtshoorn district during the past year ; there this pest seems to have a particularly bad name because of its injuries to pear trees. The

Oudtshoorn Fruit Growers' Association, which by the way seems to be the most wide-awake and energetic society of its kind that we have, had my suggestions for the treatment of the pest reprinted in the local paper, and purchased several spray pumps for the use of members. Winter spraying with lime-sulphur-salt compound has given entire satisfaction.

The citrus psylla (*Trioza* sp.) has been received from the Transvaal, Orange Free State and Natal. It has also been noticed in a very old orchard in the Carthcart division, and as no young citrus trees had been brought to the farm for many years it appears that this must be an orchard insect of long standing. In nurseries and in young orchards, action to repress it may in many instances be necessary, but no material damage seems to be done to long-established trees. The peculiar pit-like depresions produced in the foliage attracts attention to the insect's presence, and thus leads to complaint, while the ravages of many much more injurious insects are entirely overlooked.—The tree frog-hopper (*Ptyelus grossus*, Fab.) has been complained of from several localities along the frontier between East London and Seymour, and west to Grahamstown. It is another of the many insects which, metaphorically, are more bark than bite. Undoubtedly when numerous it severely taxes the resources of a tree by its rapid abstraction of sap, but owing to the constant dripping of its exudation it is easily located, and, owing to its gregarious habits and there being few colonies on a tree, it may easily and cheaply be kept in subjection by hand measures.

Enquiries for a remedy or preventive for the attack of nematode worms were made from Graaff-Reinet and Uitenhage. In the former place a patch of mangels had been ruined by the pest, and in the latter, a patch of potatoes. Badly infested potatoes from the Cathcart district were noticed on sale at the East London market in May last, and within a few months I have learned that a vineyard in the Worcester division is infested to a very serious extent. I believe, from what I have been told by farmers in various sections, that although the existence of the evil has seldom been reported, it is widespread and common in the Colony. In all the cases thus far brought to my notice the injury has been due to one species and this I believe to be the *Heterodera radicocola* Mull., found in several other countries. The worm itself is so minute that it escapes general notice ; but the nodular swellings on roots and the wart-like excrescences

on potato tubers which it causes are very characteristic. A detailed account of the pest, its injuries to plants, and of the measures available for its control, was contributed to the *Agricultural Journal* for September 6th, 1894, (Vol. vii,p. 389) by the Government Botanist.

The pear slug (*Eriocampoides limacina* Retz.), as usual, was responsible for considerable damage to pear, plum, cherry, and to a lesser extent, quince in the extreme south-western districts. I do not know this pest to have yet found its way into the Worcester division or into any section beyond. Fruit growers in all parts away from the infested area should familiarize themselves with its appearance in order that, should it become colonized in their vicinity, they may recognize it at once; by prompt measures a local outbreak might be completely suppressed at small cost. Several fruit growers have told me that their having sprayed their trees thoroughly with Paris green twice during each season for a number of years, has had the effect of so restricting the propagation of the insect that the trees no longer become badly infested. Other fruit growers, including a few prominent Constantia people, however, were as much troubled with the insect last season as ever before, despite of several sprayings every year. Inferiority of the insecticide employed is, doubtless, in many cases, wholly accountable for unsatisfactory results from spraying. In purchasing Paris green, the precaution of obtaining it from a reliable dealer who regularly supplies it for spraying purposes should be observed. Samples of two leading brands were analyzed by the Government Analyst during the year, and the results published in the *Agricultural Journal* for September 29th.

Arsenical preparations, which are said to have all the advantages of Paris green without its disadvantages of great specific gravity and injurious action on the plant tissues when used in excess, are being introduced in America, and as soon as they are procurable from manufacturers in suitable form and at reasonable prices, I will arrange to have supplies imported.

Phylloxera matters are not within the range of my duties, but for the simple purpose of information to the parties non-resident in the Colony who receive this report and who may be interested, I take this opportunity to mention that the dreaded pest continues to spread and has at last invaded the famous Constantia district. The interest which is at-

tached to the prolonged freedom of Constantia from the insect rests on the fact that the district is distant but half a dozen miles from the scene of the first outbreaks in the Colony ; these occurred about fourteen years ago. The prevailing summer winds blow from Constantia. Several centres of infestation were discovered during the latter part of the year. All the infested vines and those for many rows surrounding them were promptly destroyed by the injection of carbon bisulphide.

Migratory locusts form another subject with which I have to deal only in the most general way ; but for the same reason that phylloxera has been mentioned, I will briefly allude to them. *Pachytylus* remains not uncommon in the Karroo districts, but I have seen and heard little of it during the year. The red wing locust (*Acridium purpuriferum* Walker) is still the cause of much worry and anxiety and, to many farmers, severe losses along the eastern coast, and there seems to be a general opinion among the farmers that its numbers are not decreasing. The Bacteriological Institute has done excellent work in spreading the " locust fungus disease " (considered to be *Empusa grylli* Fres.) among the swarms, and has thus been instrumental in destroying myriads of the pest. There is, however, a feeling which appears to be gaining ground among the suffering farmers, that legislation should be enacted to enforce the application of more direct measures against the early stages. To my mind, the Government should give this subject immediate consideration. *Zonocerus elegans*, Thunb., (so named in South African Museum) a stout bodied, very short winged locust, conspicuous by bands of yellow about its otherwise black antennæ, was reported a garden pest from Vryburg and other northern places. The Director of the Bacteriological Institute has informed me that this species may be destroyed by the fungus disease.

APPENDIX A.

Abstracts from contributions to *Agricultural Journal* in relation to the need of legislation for the codling moth and other orchard pests.

(*From Issue for November 10th*, 1898.)

The only legislation that affects the codling moth in this Colony is that requiring the absence of pests in imported fruit. It is an anomaly which demands correction that there are no restrictions whatever on the sale of infested fruit within the Colony. Graaff-Reinet people may now send "wormy" apples and pears all over the country if they so please, but no fruit dealer is permitted to take possession of a single fruit consigned to him from abroad if codling moth in any stage is found in the case. The consignment is condemned and destroyed. The same anomaly extends to trees. No pest-infested tree is allowed to pass our ports; but within the Colony a man may allow his trees to be a hot-bed of infection. And, as indicated in a foregoing paragraph, the codling moth is a pest which may be readily spread from garden to garden—far more readily than scale insects.

To be on an equivalent with our just and desirable port legislation, it would be necessary for us to have compulsory orchard and garden legislation applicable for the whole Colony,—such legislation to require suppression of all fruit pests wherever they occur. But a fair consideration of the question will show that there are many reasons why such broad legislation is undesirable, and that even if it were secured it could not be successfully enforced. With regard to the codling moth, it would affect not only parties growing fruit commercially, but also those growing fruit on a small scale for home use. In numbers the latter class of growers doubtless far outnumbers the former; and these small growers are those least interested in the suppression of the pest, for to them remedial measures involve more trouble than they consider the fruit otherwise lost is worth. Again, however drastic the legislation there is practically no possibility of eradicating the pest. As regards these two circumstances, the question is not comparable with that of scab in sheep, since sheep are kept almost entirely for profit and the possibility of eradication is acknowledged. The rigid en-

forcement of compulsory orchard and garden legislation would naturally, therefore, excite great opposition in some quarters. But a still thornier factor in the case is encountered. The measures for the suppression of the codling moth are not as simple as the dipping of sheep. Spraying to be effective must be done not only thoroughly but at a certain time—the proper time varying with the local conditions and with the season, and not determinable with exactitude without watching the development of the young fruit. A similar difficulty attends banding ; an inspector might easily see that the bands were applied as demanded by law, but not that these were faithfully examined at proper intervals. These facts would render efficacious enforcement of compulsory orchard and garden legislation very costly and troublesome. Most colonists realize this and know that similar objections hold with regard to other pests ; and it is becoming generally accepted that the only form of a bill likely to receive sufficient support to be made law is a permissive measure making the application of remedies for pests and diseases of fruits compulsory only in such districts as request its enforcement.

Such a permissive measure should be of great value to the country, and of greater value still were it made to include a clause, applicable to the whole Colony, prohibiting the transportation in public conveyances and the public sale of pest-infested or diseased fruit ; thus leaving home consumption and local fruit-preserving factories the only outlets for this undesirable commodity. The proper enforcement of a clause to this effect would not altogether prevent infected fruit being sold since some would slip through in the sorting—it being sometimes difficult to detect infestation ; but it would most decidedly improve the quality of fruit sold in our markets and stimulate the adoption of remedial measures.

A permissive measure (The Plant Disease and Insect Pest Bill, 1895), drawn up by Government officials, was introduced a few years ago ; but it failed to receive the support of those in whose interests it was framed, and was consequently dropped. Since then the fruit-growers in various parts of the Colony have banded themselves into fruit growers' associations, and, both east and west, have appointed horticultural boards to advise Government relative to horticultural interests. It now remains for these representative bodies to present draft measures of the legislation deemed necessary to safeguard the interests of the people represented—the existence of these advisory bodies obviating the

necessity for officials to again chance failure. May an acceptable measure be soon forthcoming.

C. P. L.

(*From Issue for March 2nd*, 1899.)

The codling moth is spread in two main ways,—by the winged insect flying or being carried by the wind and by the larva being transported with fruit. The first means accounts chiefly for local spread and the second for spread from town to town. Most varieties of pears decay too rapidly when infested to be marketable, but apples generally last long enough to get to the consumer. It is natural for infested fruit to ripen prematurely and in high winds much of it falls to the ground ; as there is some demand for a fruit early in its season, however poor it may be, it follows that fair payment is received for these " worm-eaten " windfalls. It may be business for the fruit-grower to sell such fruit. In the first place, he gets well paid for it and in the second he rids his orchards of many larvæ without trouble. But while from his private point of view, it may be desirable that he dispose of such fruit on the public market, it is far from desirable from a public point of view, for there is considerable risk that this fruit will be the means of carrying the pest to hitherto clean localities. Aside from this weighty objection, the sale of poor fruit has a bad influence on the market by discouraging the consumption of fruit and by depressing prices. It is too early, perhaps, to observe these disadvantageous effects in our colonial markets, but they are reported to be felt in the markets of other countries and will doubtless be increasingly appreciated here as the supply of fruit at reasonable prices nearer approaches the demand. It is full time to begin to educate the public taste up to good, sound fruit, and an important step in this direction would be prohibition on the sale of fruit befouled by the codling moth. Secured now, such a legislative measure would do much both directly and indirectly in staying the progress of the pest, and no other form of legislation would more stimulate the adoption and faithful prosecution of repressive measures. If no legislation is enacted to prevent it, more and more infested fruit will reach our markets yearly. Last year we failed to notice any on sale in Cape Town fruiterers' shops, although on the watch, while this year we noticed small lots on sale in both town and suburbs.

C. P. L.

APPENDIX B.

Trappes Valley and Oudtshoorn Fumigation Clubs.

The extent of the fumigation operations carried on during the past year, and the arrangements for the control of the various co-operative fumigation outfits, were discussed in the body of the report. It is deemed desirable, however, to add as an appendix the following more complete information regarding the two most important of these co-operative outfits, one operated by the Trappes Valley Fumigation Board, and the other by the Oudtshoorn Fruit-Growers' Association.

A circular letter requesting a report on its work to the close of the year was addressed from this office to each fumigation club, and in this letter it was intimated that the report should state :—

1. The number of trees and number of orchards or gardens fumigated up to January 1st.
2. The terms with the manager.
3. The terms for work, including statement of the arrangements prevailing, (*a*) for the transport of the outfit, (*b*) with regard to labour, (*c*) with regard to board and lodging of manager, (*d*) with regard to the charges per tree treated.
4. The doses of chemicals employed.
5. Whether or not the covers have proved satisfactory, and if trouble was experienced in ripping of seams, with the loops, or from mildewing of the cloth.
6. If the work has given satisfaction.

In reply the honorary secretary of the Trappes Valley Fumigation Board wrote :—

1. 8,678 trees have been treated in 22 gardens.
2. The manager is a European and is paid £12 a month while the work lasts.
3. (*a*) The party requiring the outfit fetches it from the railway station or from the place where it was used last. (*b*) The Board allows wages for two boys only ; other boys as required must be supplied by the farmer. (*c*) The manager has a good tent to live in, but he has to make his own arrangements as to board, &c. (*d*) The charge is based

on the size of cover employed. For size I tent cover it is 1s. per tree ; for size II, 1s. 3d. ; III, 1s. 6d. ; IV, 1s. 9d. ; for size I sail cover, 1s. 9d. ; size II sail, 2s. ; III sail, 2s. 3d. ; IV sail, 2s. 6d. ; V sail, 2s. 9d.

4. Doses of chemicals as recommended in the "Gas Treatment" pamphlet are used.
5. The covers on the whole are satisfactory and have stood wear and tear better than was expected at first. The largest sheets have shown a tendency to rip in the seams.
6. All have expressed great satisfaction with the result of the work ; its success exceeds expectation.

(Signed) JOHN QUAIL,
Secretary.

The response from the honorary secretary of the Oudtshoorn Fruit-Growers' Association reads :—

1. There have been 4,127 trees in 110 orchards fumigated from 1st February, 1898, when operations were commenced, to the 1st January, 1899.
2. The manager is paid £12 per month.
3. Our charges are :—per tree under 10 feet, 2s. ; between 10 and 15 feet, 3s. 6. ; 15 and 18, 6s. 6d. ; 18 and 20, 10s. ; 20 and 24, 15s. It is probable that this scale of charges will be amended at our next general meeting, and that thereafter the charges will be based on the quantities of chemicals used. We have our own waggon, which cost £77 10s., specially built for the conveyance of our outfit. We also provide our manager with a horse. . . . The farmers provide draught animals. We pay a coloured foreman £3 10s. per month, and three other men £3 a month each. The men have to make their own arrangements as to living. The farmers are generally glad enough to extend their hospitality to our manager gratis, but this is his own lookout.
4. Our manager uses doses nearly 30% larger than those given in the table supplied by your office.
5. (Much contracted). . . .After giving them a thorough trial, our manager, Mr. Morton Just, reported that the oiled covers first supplied were inferior in every way (except being more gas-tight) to the heavier unoiled covers as they tore easily

and had to be constantly patched. He tried greasing one of the larger sails with tallow in the same way as our farmers do their "buck-sails," but found that this did not answer as it only made the sheet heavier and more difficult to handle. [It became heavier through soil clinging to its greasy surface. C. P. L.]. . . . The seaming of the large sheet covers might be stronger. There has been no trouble on account of loops giving way, nor the slightest mildewing of the cloth ; the latter may be attributed to the dryness of our climate, but our manager is very careful to have the covers perfectly dry before folding them. . . . For patching small holes we find it best to use raw paste instead of the needle.

6. The work has given the greatest satisfaction in this district, and has to a great extent saved our citrus fruits. As unfortunately, however, many other trees, some of them indigenous, take scale readily, I am of the opinion that we must look upon the hydrocyanic acid gas process as merely a check, and continue to pray for the advent of the natural enemy of *Aspidiotus aurantii.*

(Signed) FRANK MULLER,
Secretary.

The Trappes Valley outfit originally consisted of twenty tent covers and five sheet covers, all of eight ounce duck oiled ; two of the sheets had a three foot margin of drill all around. There has since been added six tent and two sheet covers of ten ounce duck oiled, and a few tent covers of Willesden rot-proof sixteen ounce duck. The sizes of covers mentioned are used for trees up to 5, 7, 9, 12, 14, 16, 18 and 20 feet in height respectively. A discount on the schedule charges is allowed in the case of large orchards. The Oudtshoorn has had eight tent and three sheet covers of eight ounce duck oiled and eight tent and four sheet covers of heavy cloth unoiled ; most of the latter are made of No. 10 duck, and these are preferred to the oiled ones. The charges for fumigation are necessarily high at Oudtshoorn because of the small number of trees treated at each place ; the average is less than thirty-eight ! The work has shown a good profit, however, and all the surplus over the cost is the joint property of the members. The charges will be less under the new schedule.

GENERAL INDEX.

A.

PAGE

Aberia caffra, attacked by fruit-fly 38
Acacia horrida, caterpillars of Antheræa tyrrhea feeding on 50
mollissima, a food plant of Antheræa cytherea 50
saligna, leaves stripped by caterpillars of Antheræa tyrrhea ... 49
Acacia bag worm of Natal, illustration of, fig. 5, Plate V.
Acherontia atropos, the death's head moth in St. Helena 33
Acræa horta, lavæ destroying Kiggelaria africana 51
Acridium purperiferum, still causing severe losses in Eastern Province 58
Adoretus capicola, damaging foliage and fruit of grape 52
hand gathering the most successful remedy, turkeys in vineyard for 53
Agricultural Journal, list of contributions to 4
Amblyomma hebræum, notes on, incubation period of eggs of 43
American aloe, Aspidiotus nerii on 21
flower-stalks for fumigation poles 19
Amendments proposed to peach yellows regulations, text of 12
Antestia variegata, a fruit puncturing bug, damage caused by 46
illustration of, fig. 2, Plate II.
Antheræa cytherea, larvæ feeding on Acacia mollissima, apple, oak and rose, parasite of, pine plantations, damage in 50
tyrrhea larvæ feeding on Acacia horrida and Acacia Saligna 49
egg cluster, illustration of, fig. 3, Plate V.
Aphis, Woolly, checks of in England 34-5
notes on 46
Apple and quince borer, notes on 51
illustration of, figs. 1 and 2, Plate V.
Araucaria scale, a ladybird destroying 28
illustration of, fig. 5, Plate II.
Argas reflexus, notes on 45
Argas sp., illustrations of, figs. 1, 2 and 3, Plate IX.
Agave americana, scale insect on 21
use for flower-stalks of 19
Arsenical preparations, notice of new 57
Artist, appointment of a departmental 4
Asafœtida, to deter fruit-fly attack 39
Aspidiotophagus citrinus, a parasite of the red-scale 31
Aspidiotus aurantii, the common red-scale 35
camelliæ, effect of fumigation on 21
the greedy scale 35
nerii, effect of fumigation on 21
the oleander scale 35
perniciosus, the San José scale 32
Aspongopus nubilus, a melon and pumpkin bug 48
Asterolecanium sp., a beneficial native scale insect 36
Aulacophora vinula, feeding on melon-vines 55
Australia, fruit-fly in Western 38
ladybirds from 28
ladybirds sent to 30
Australian bug, about Lisbon, Portugal 25
effect of fumigation on eggs of 21

B.

PAGE

Bagrada hilaris, a common garden pest, on cruciferous plants, maize and potatoes 46
illustration of, fig. 1, Plate II.
Bag worms, of the vine at Worcester..... 51
illustrations of, fig. 4, Plate V.
Bamboo borer 55
illustration of, fig. 5, Plate VIII.
Beetle, the keever, injuring newly planted fruit trees..... 52
Bisulphide of carbon, suggested for calandra..... 41
Blaauw biesje, an orchard pest..... 53
illustrations of, Plate VII.
Blue or Blood tick, the local transmitter of red-water..... 44-5
not identical with American or Australian forms..... 45
illustration of egg, fig. 6, Plate IX.
Bont tick, complaints of, increasing in many districts, incubation period of eggs of..... 43
illustrations of male, figs. 4 and 5, Plate IX.
Bont-leg tick, complaints from Midland districts, incubation of eggs of, longevity of young without food..... 44
Boöphilus bovis, reference 45
Borers, in American stock imported into Natal..... 14
in apple and quince..... 51
in bamboo 55
in osier and willow..... 52
wash to deter 14
Bostrychus cornutus, a bamboo borer..... 55
illustration of, fig. 5, Plate VIII.
Bryobria mite, Bryobria pratensis, complaints of from Oudtshoorn, injurious to pear trees..... 55
winter spraying with lime-salt and sulphur..... 56
Buddleia, sp., Cossus tristis boring in, reference..... 51

C.

Cabbage Moth, prevalence in 1898..... 48
illustrations of, Plate IV.
Calandra, black, reference..... 53
of the vine 40-2
carbon bisulphide suggested for..... 41
gas-lime experiments against..... 40-1
in orchards, life history of, on indigenous plants..... 42
pocket traps for 41
illustrations of, figs. 1-4.. Plate VIII.
Ceratitis capitata, see under fruit-fly.
Ceylon, ladybirds from 27
ladybirds sent to..... 28
Chilocorus circumdatus, a Ceylon ladybird..... 27
Citrus psylla, in Cathcart, Natal, O.F.S. and S.A.R..... 56
Cloth for fumigation purposes, details in preparing, objections to oiled covers 16
unoiled covers preferred to oiled, but not gas-tight..... 17
greasing cloth inadvisable, rot-proof canvas for, unbleached calico for..... 18
Codling moth, a coming difficulty..... 37
illustrations of various stages, Plate III.
spread by means of..... 61
suppression of, measures for..... 60
legislation for 59
Coleus, effect of hydrocyanic acid gas on..... 22

PAGE

Contributions to Agricultural Journal..... 4
Correspondence of Entomological Branch..... 5
Co-operative fumigation clubs, government grant to, list of..... 14
managements of outfits of..... 15
details of working of Oudtshoorn and Trappes Valley..... 62-3
Cossus tristis, boring in apple and quince..... 51
illustrations of, figs. 1 and 2, Plate V.
Covers, fumigation 18
Cresoline, useless as a deterrent for fruit-fly..... 40
Cut-worms, reference 49

D.

Dactylopius bromeliæ, pineapple mealy bug..... 36
Dactylopius, see mealy bugs.
Deciduous trees, fumigation of, not recommended..... 20
Dendrolimus capensis, caterpillars destroying Acacia saligna, mistaken for the gypsy moth..... 50
Destructive pests which might be introduced to Cape..... 7
Deterrents, for fruit-fly, odours and washes..... 39
Deterrent wash for borers..... 14
Device for manipulation of sheet covers..... 18
Diaspis amygdali, the white-peach scale, effect of fumigation on.. 21
in Mauritius 34
in St. Helena..... 32
on Acacia and Solanums..... 34
parasite of 32
Dishes, fumigation, china recommended..... 19
Doses, fumigation, under unoiled covers..... 17
Drosophilidæ, vinegar flies, attack mistaken for fruit fly..... 38
Dwelling houses, fumigation of with hydrocyanic acid, a dangerous practice 24

E.

Eastern Province, Horticultural Board, reference..... 12
Empusa grylli, locust fungus..... 58
Epilachna chrysomelina, complaints of from Karoo, destructive to cucurbs 54
similis, a garden pest..... 54
Eremnus atratus, an orchard pest, ref..... 53
Eriocampoides limacina, pear slug, notes on..... 57
Eriococcus araucariæ, Norfolk Island pine scale, ladybird destroying 28
illustration of, fig. 5, Plate II.
Eucalyptus decoction, to deter fruit fly..... 40
Exportation of Cape ladybirds..... 28
to Ceylon 29
to New South Wales..... 31

F.

Field work and investigations..... 3
Formicomus, sp., destroying vegetables at Upington..... 55
Fowl tick, Argas sp., complaints from various sources, compared with fowl ticks of America, Australia and India, probably identical with Argas reflexus, great vitality of..... 45
effect of hydrocyanic acid gas and oils on..... 46
illustrations of, figs. 1, 2 and 3, Plate IX.

PAGE

Fruit fly, Ceratitis capitata, attacking Aberia caffra, Opuntia tuna, Passiflora cœrula, Solanum capsicastrum, proof of..... 38
Experiments with odours, &c., to deter oviposition..... 39
netting to protect fruit from, new food plants, reported infection of Solanum niger and S. sodomæum in Western Australia 38
the remedy, daily gathering of windfalls..... 39
Fumigation with hydrocyanic acid gas, amount of cyanide required for nursery chambers..... 20
chambers for nurseries..... 24
covers of rot-proof canvas..... 18
doses under unoiled covers..... 17
effect on eggs of Icerya purchasi..... 21
effect on coleus plants, and Orthezia insignis in glass-houses 22
fowl ticks 46
mealy bugs 21
in dwelling houses, discouraged..... 24
glass houses, practicable..... 22
not recommended for deciduous trees..... 20
of all imported plants desirable..... 10
of citrus trees, general satisfaction with results..... 19
uncertainties of 20
use of china in place of leaden dishes recommended..... 19
Fungus checks for scale insects..... 32

G.

Gas lime, experiments with, against the vine calandra..... 40
Gelechia solanella, common in potato growing sections, in imported potatoes. from Portugal..... 48
illustrations of, Plate VI.
Generating dishes, china substituted for leaden..... 19
Glass house fumigation, ref..... 22
Grass epilachna, a garden pest..... 54
Grape bag worm..... 51
illustration of, fig. 4, Plate V.
Gypsy moth, supposed outbreak..... 50

H.

Haltica indigacea, the blaauw biesje, in Western Province orchards 53
notes on life history, larvæ attacked by a wasp parasite..... 54
illustrations of, Plate VII.
Harpuis bush scale, a beneficial insect..... 36
Heliothis armiger, eating into green peaches, injurious to green mealies and tomatoes..... 49
illustrations of, Plate IV.
Hermitage grapes, attacked by vinegar flies..... 38
Heterodera radicocola, injurious to mangels and potatoes..... 56
Horticultural Boards urged to consider orchard legislation..... 9
Holopterna valga, an injurious garden bug, eggs of, ordour of.... 47
illustrations of, figs. 3 and 4, Plate II.
Hyalomma ægyptium, bont-leg tick, notes on..... 44
Hydrocyanic acid gas, see under Fumigation.

I.

Icerya purchasi, see Australian bug.
Imported plants, examination of..... 4
fumigation of all, recommended..... 10
Incubation period of bont tick eggs..... 43
of bont-leg tick eggs..... 44
Insect legislation discussed..... 7
Introduction of ladybirds, from Australia, from Ceylon..... 27

J.

PAGE
Jarring for fruit-tree beetles..... 54

K.

Karoo caterpillar, less destructive than usual..... 49
Keever beetle, injurious to newly set fruit trees..... 52
illustration of, fig. 7, Plate VIII.
Kel apple, attacked by fruit fly..... 38
Kiggelaria africana, propagation impeded by attack of Acræa horta larvæ at Tokai..... 51

L.

Ladybird, local distribution of vedalia..... 24
sendings of vedalia to Portugal..... 25
and St. Helena 26
useful species, attempted introduction from Ceylon..... 27
and New South Wales..... 28
useful species exported to Ceylon and New South Wales..... 28
Lecanium oleæ, an uncommon but widespread species in Cape, controlled by a wasp parasite..... 32
viride, ref. 30
Lime for Calandra, success of in 1893..... 40
vine growers should experiment with..... 41
Linen stained by larvæ of Antheræa tyrrhea..... 49
eggs said to be destroyed by larvæ of Mylabris beetles..... 55
Locusts, still the cause of severe losses, fungus, Empusa grylli, destroys Zonocerus elegans, red-wing still destructive.... 58
Loxostege frustalis, the Karoo moth..... 49

M.

Malacosma borrei, troublesome to vines, jarring recommended for 53
Mealy bugs, effect of fumigation on..... 21
abundant on fig, granadilla, grape and guava..... 35
oleander infesting 21
on pineapple, in East London and Natal..... 36
Melon epilachna, complaints of in Karroo districts..... 54
Monochelus natalensis and M. calcaratus, destroying wattle foliage 55
Mylabris beetles, destructive in homestead gardens, handpicking recommended, larvæ said to prey on locust eggs..... 55
illustration of Mylabris oculata, fig. 10, Plate VIII.
Mytilaspis citricola, eradication of by ladybirds in Hawaii..... 28

N.

Natal, a fumigation outfit for..... 4
imports trees from peach-yellows districts in U.S.A..... 14
should co-operate in checking introduction of plant pests and diseases 13
Nematode worms in mangels and potatoes..... 56
potato affected by, see fig. 7, Plate IX.
Netting to protect fruit from fruit fly, 20,000 yards imported and distributed 38
how to cover trees with..... 30
Norfolk Island Pine Scale (fig. 5, Plate II)..... 28

PAGE

Number, total of citrus trees fumigated in 1897 19
by Oudtshoorn Club 19
by Trappes Valley Club 20
Nurseries Bill discussed 7
Nurseries with fumigation chambers, list of 20

O.

Odontionopa sericea, a fruit-tree pest, attacks native shrubs, early stages unknown 53
illustrations of, Plate VII.
Odours to deter fruit fly 39
Opuntia tuna, prickly pear fruit, attacked by fruit fly 38
Orchard fumigation, discussed, formation of co-operative clubs, government aid towards 14
legislation, necessity for, increasing 9
discussed 59
Ornithodorus savignyi, a man attacking tick 46
Orthezia insignis, discovery of in Cape 36
occurrence in Ceylon and Reunion, tea and coffee plants affected in Ceylon 37
illustrations of various stages, &c., Plate I.
Oudtshoorn fumigation club, work done by 19
details of management and extent of work 63

P.

Pachytylus, still common in Karroo 58
Paris green, substitutes for 57
Passiflora cœrula, fruit fly attacking 38
Peach-yellows and peach rosette, amendment of regulations recommended 10
approved of by Horticultural Board 12
area in U.S.A., infested by 11
amended proposals 12
non-existent in the American West 13
Natal does not restrict importation of stone fruits from districts infected with 13
Peach scale, white, in St. Helena and Mauritius discussed, a cosmopolitan pest 32-4
Pear-leaf mite, unusually prevalent 55
Pear, woolly aphis on 46
Pear tree slug, injurious to cherry, pear, plum and quince, successful use of Paris green for, failure of due to inferior material .. 57
illustrations of, Plate VI.
Pentzia virgata, the Karroo bush, destroyed by caterpillars 49
Pests which might be introduced to Cape 7
Phlyctinus callosus, see calandra of the vine 40
illustrations of, figs. 1-4, Plate VIII.
Phryneta spinator, injurious to bark and young wood of fig and pear 55
illustration of, fig. 6, Plate VIII.
Phylloxera, continuous spread, invasion of Constantia district 57
carbon bisulphide used in combatting 58
suspected case at Robertson 53
Phytoptus pyri, see pear-leaf mite 55
Pineapple mealy bug, destructive in East London 36
Plant disease and insect pest bill, ref 9
discussed 60

PAGE

Plantations, damage by insects, in Kiggelaria africana..... 51
in pine 52
Plutella cruciferarum, see cabbage moth..... 48
illustrations of, Plate IV.
Pocket-traps for vine calandra..... 41
Porthetria dispar, the gypsy moth..... 50
Ports, provisions for gassing plants at..... 10
Portugal, vedalia sent to..... 25
Potato tuber moth, local occurrence, in potatoes from Portugal... 48
illustrations of, Plate VI.
Prickly pear, fruit fly attacking..... 38
Prosopophora, the thorn tree scale..... 36
Psylla, citrus, occurrence of..... 56
Psyllids, eaten by Exochomus nigromaculatus..... 28
Ptyelus grossus, complaints of..... 56
Publications of Entomological Branch, list of..... 5

Q.

Quassia and syrup to deter fruit fly..... 40
Quince and apple borer, Cossus tristis..... 51
illustrations of, figs. 1 and 2, Plate V.

R.

Red tick, the common, identity of..... 44
Rhabdotis semipunctata, a fruit beetle.....
illustration of, figs. 8 and 9, Plate VIII.
Rhipicephalus annulatus, the American red-water tick..... 45
australis, the Australian red-water tick..... 45
decoloratus, the supposed red-water tick of the Cape..... 45
evertsi, the common red tick..... 44
Rot-proof canvas, importation and use of for fumigation covers.. 18
Rumex obtusifolia, the common dock, a food plant of the blaauw biesje 54

S.

San José scale, might be easily introduced to the Cape, 50,000 trees killed by, in Maryland, U.S.A..... 7
Scale insects, ref. 35-7
fungus checks for..... 32
international exchange of natural enemies of..... 27
two native beneficial species..... 36
Schinus molle, a food plant of Antheræa cytherea..... 50
Sheet covers, alteration in details of uprights manipulation of, simple device for hoisting sheet..... 19
Schizoneura lanigera, see the woolly aphis.
Shining black lady-bird, exportation of, feeds on aphides, woolly aphis, araucaria scale, psyllids and many scale insects..... 28
Solanum aculeastrum, greedy scale on..... 21
capsicastrum, attacked by fruit fly..... 38
nigrum and sodomæum, said to be attacked by fruit fly in Western Australia, not so in Cape..... 38
Sphærostilbe coccophila, parasitic fungus of the San José scale.... 32
Stockholm tar, to deter fruit fly attack..... 40
Stone fruits, restrictions on importations of from America, see also peach-yellows 10

T.

PAGE

Tar and soda, to deter fruit fly attack..... 39
Thorn-tree scale, a beneficial scale-insect, destructive to thorn trees 36
Tobacco-dust remedy for woolly aphis..... 46
Tomato worm 49
illustrations of, Plate IV.
Tong blaar or dock, eaten by blaauw biesje..... 54
Trappes Valley Fumigation Club, number of trees fumigated by.. 19
details of management of, &c..... 62
Trioza sp., citrus psylla, occurrence of..... 56
Twig wilter bug, a common garden pest..... 47
illustrations of, figs. 3 and 4, Plate II.

U.

Unoiled covers for orchard fumigation, larger doses needed in using 17

V.

Vedalia ladybird, how collected and despatched, local distribution of, sent to Portugal successfully and to St. Helena, failure of past sendings to St. Helena, number colonies sent out.... 24
Vinegar flies, in Hermitage grapes, mistaken for attack of fruit fly 38

W.

Willow and osier borer, ref..... 52
Woolly aphis, discussed 34
appearance of winged generation..... 46
why not so injurious in England ?..... 34-5
tobacco-dust remedy 46
Work of Office..... 1

Z.

Zonocerus elegans, reported a garden pest, killed by locust fungus 58

Explanation of Plate I

Orthezia Insignis Douglas

1.—Twig of coleus infested with Orthezia insignis. Natural size.

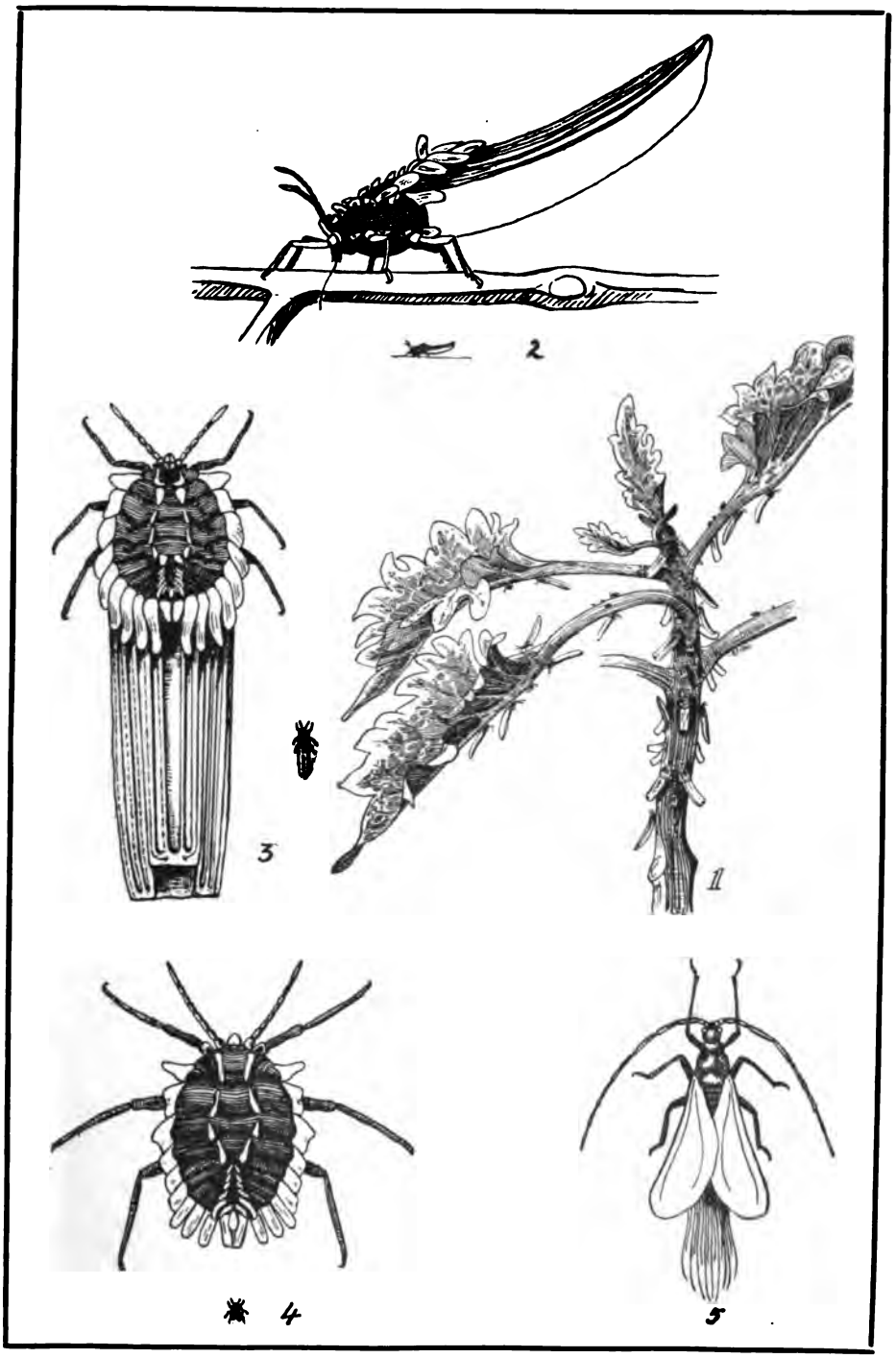
2.—Adult female, side view. Greatly enlarged and natural size.

3.—Adult female, top view. Greatly enlarged and natural size.

4.—Immature female. Greatly enlarged and natural size.

5.—Adult male. Greatly enlarged (after *E. E. Green*).

PLATE I.



Claude Fuller, del.

THE ORTHEZIA.

Explanation of Plate II.

1.—The Bagrada Bug, *Bagrada hilaris*, Burm. Enlarged and natural size.

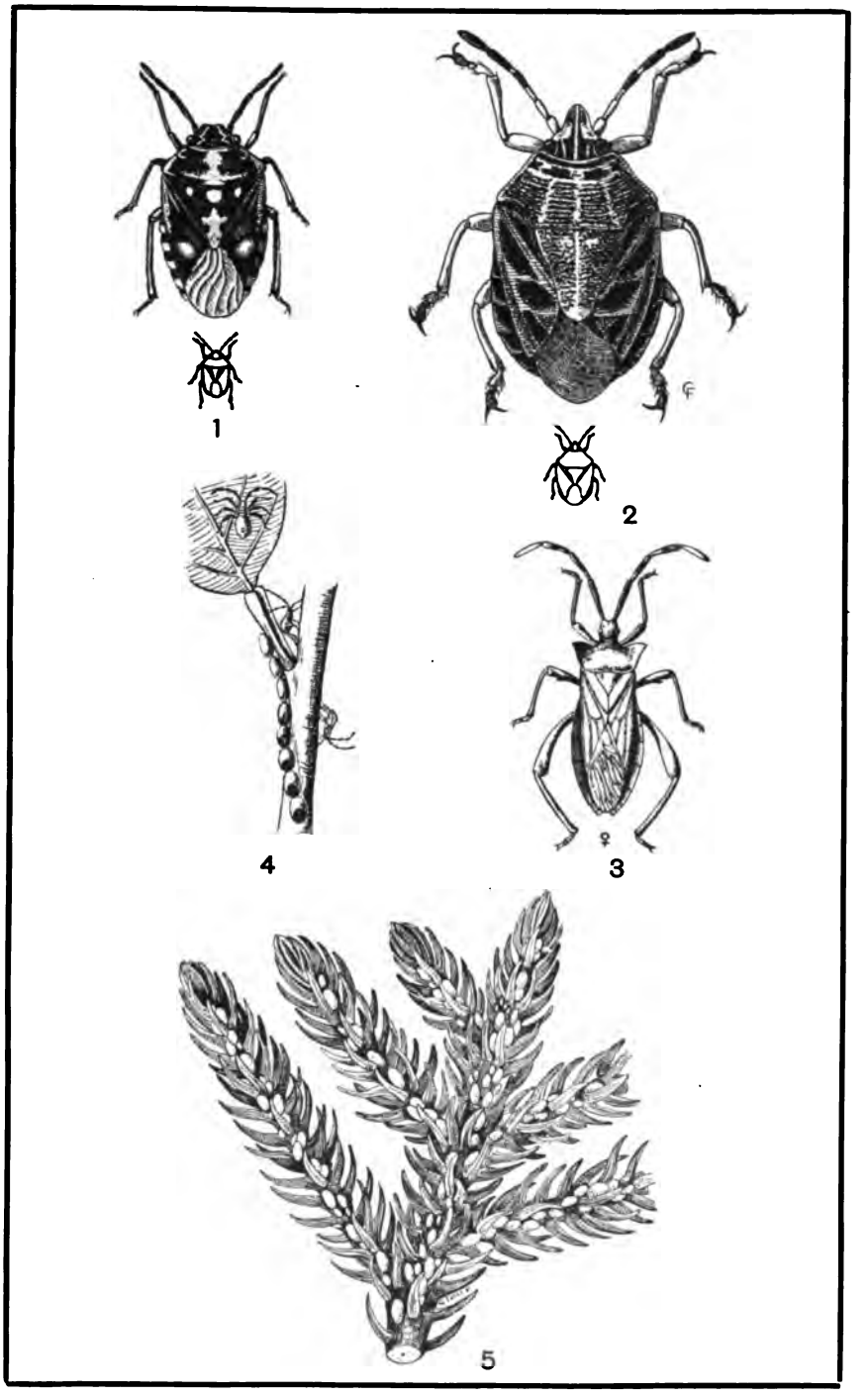
2.—A Fruit Puncturing Bug, *Antestia variegata*, Thunb. Enlarged and natural size.

3.—The Twig Wilting Bug, *Holopterna valga*, Linn. Natural size.

4.—Eggs of same and newly-hatched young. Natural size.

5.—The Araucaria Scale, *Eriococcus araucariæ* Mask. Natural size.

PLATE II.



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Explanation of Plate III.

The Codling Moth.

(Carpocapsa pomonella, Linn*).*

1.—Young pear with eggs as laid by female at *a.a.* Natural size.

2.—Adult worm. Much enlarged.

3.—Adult worm. Natural size.

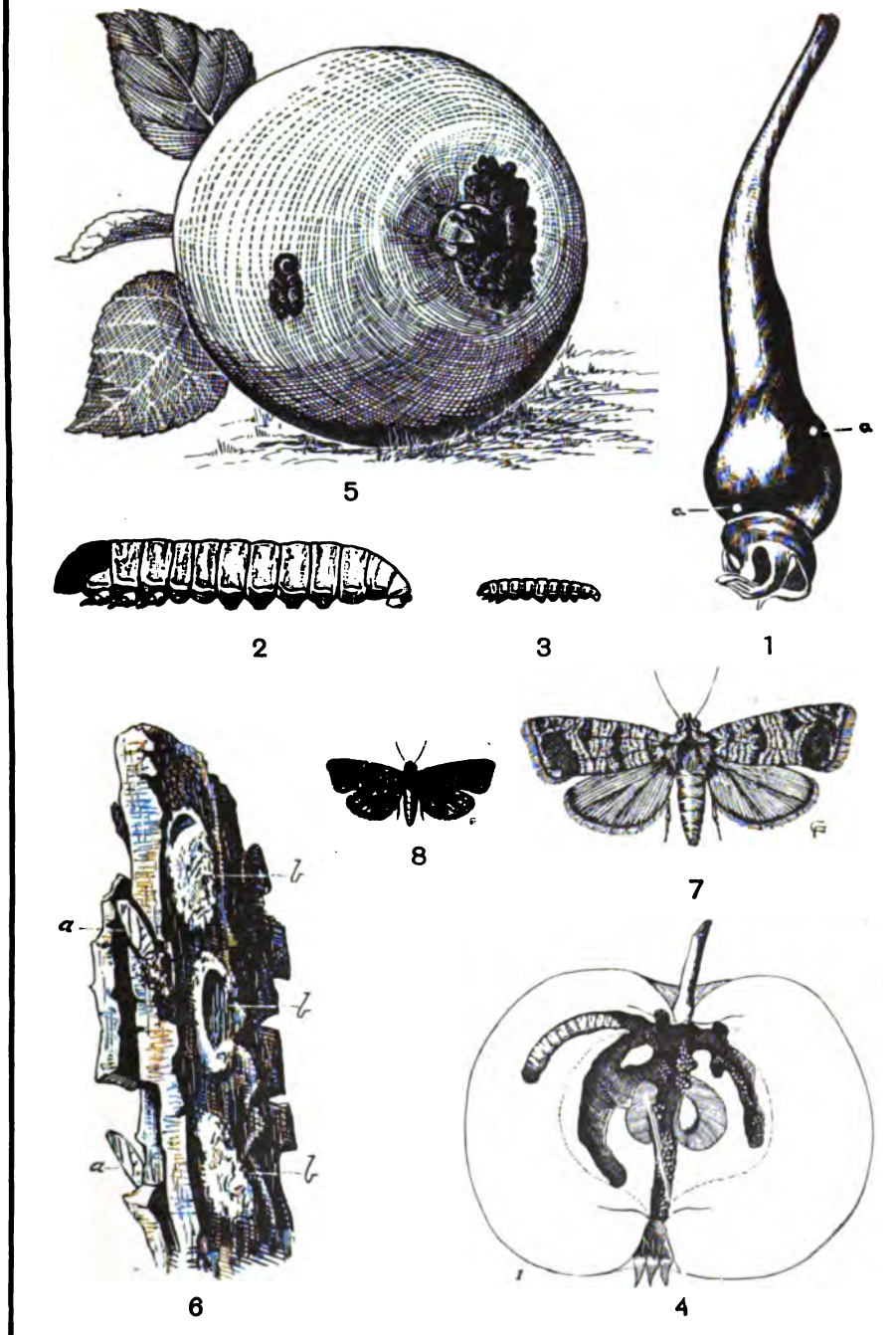
4.—Section of apple showing tunnellings of worm and worm at work.

5.—View of apple showing external indications of codling moth infestation.

6.—Side and back view of a piece of bark showing cocoons at *b.b.* and pupæ at *a.a.*

7.—The codling moth. Enlarged

8.—The same. Natural size.



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THE CODLING MOTH.

Explanation of Plate IV.

The CABBAGE MOTH, *Plutella cruciferarum* Zell. (from U.S.A. Department Agriculture).

a.—Larva or worm. Enlarged.

b, *c.*—Enlarged views of single segment of larva.

d.—Pupa or chrysalis. Enlarged.

e.—Cocoon. Enlarged.

f.—Moth. Enlarged.

g.—Wing of the dark variety. Enlarged.

h.—Moth at rest. Enlarged.

i.—Cremaster of pupa. Greatly enlarged.

The TOMATO or MEALIE WORM, *Heliothis armiger*, Hübner (from U.S.A. Department Agriculture).

Full-grown Worm eating into a Tomato. Natural size.

a.—Egg, side view. Enlarged.

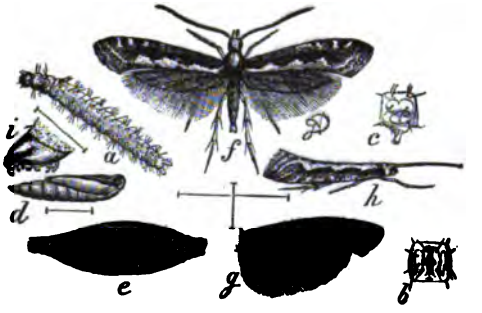
b.—Egg, top view. Enlarged.

c.—Full-grown worm.

d.—Earthen cell containing pupa.

e.—Moth with wings spread. Natural size.

f.—Moth at rest. Natural size.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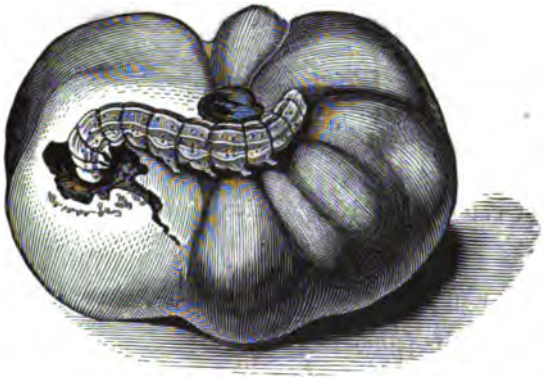

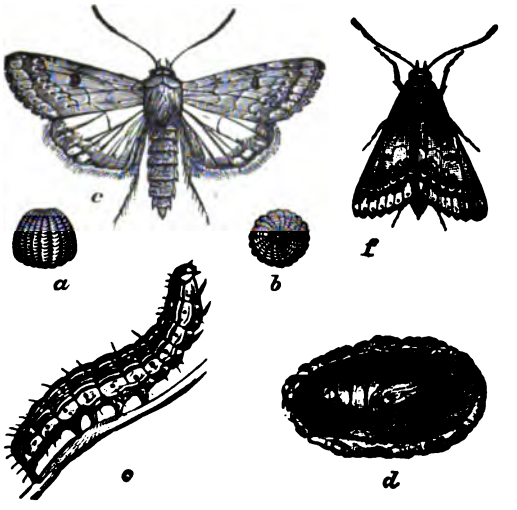
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Explanation of Plate V.

1.—Apple Borer, *Cossus tristis* Drury. Portion of limb showing the work of the Borer Moth, and pupæ *in situ*. Natural size.

2.—Larva or caterpillar. Natural size.

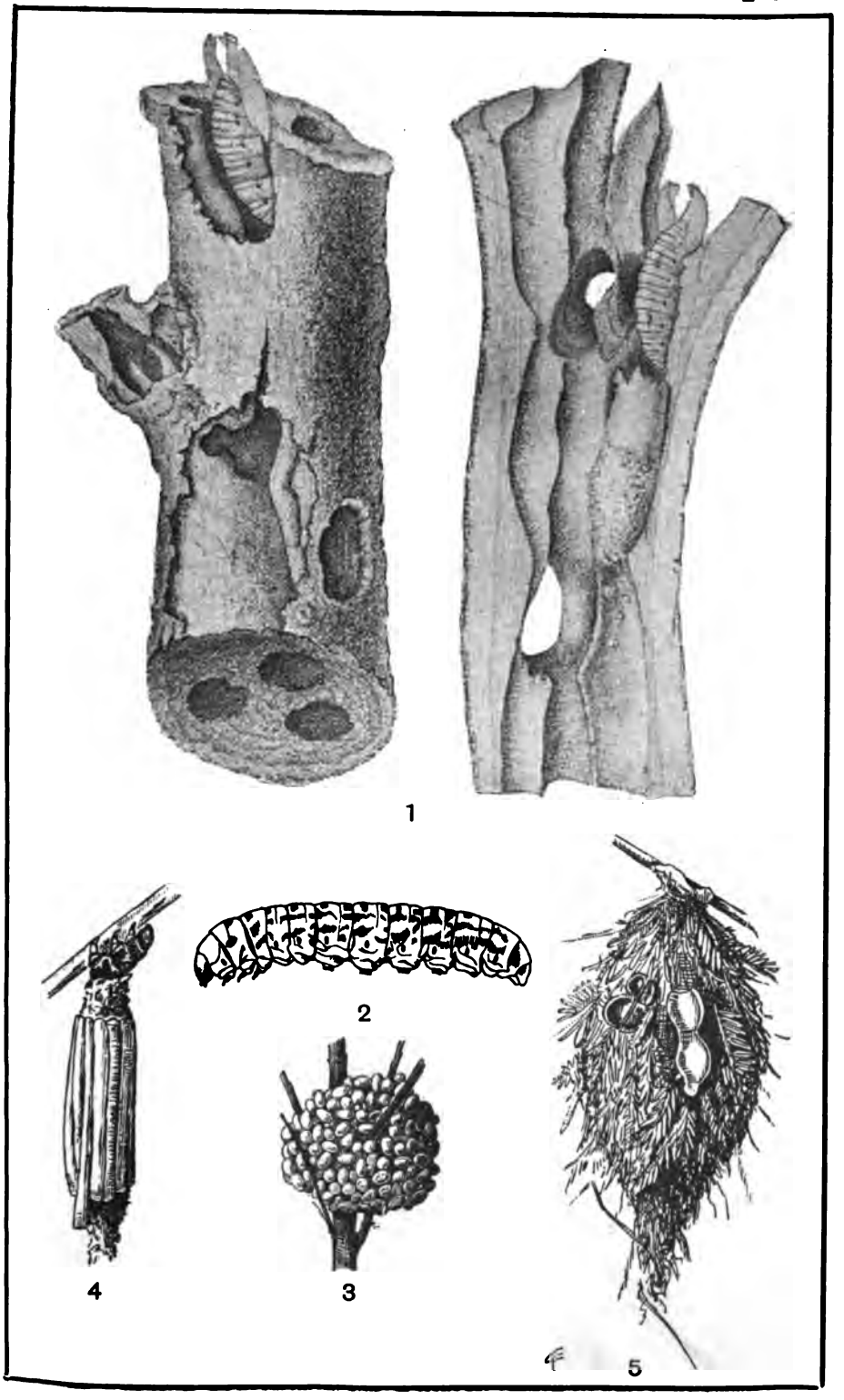
3.—Egg cluster of *Antheræa tyrrhea*. Natural size (This egg cluster closely resembles that of *Dendrolimus capensis*).

4.—Grape-vine Bag-worm.

5.—Acacia Bag-worm, of Natal.

(Fig. 1 by *Arthur Rich*. 2, 3, 4 and 5 by *C. Fuller*).

PLATE V.



Explanation of Plate VI.

The Potato Tuber Moth, *Gelechia solanella* Boisd.
(from U.S.A. Department Agriculture).

a.—Piece of potato tuber showing eye and eggs deposited about it. Natural size.

b.—Egg, top view. Greatly enlarged.

c.—Egg, side view. Greatly enlarged.

d, *k*.—Tunnellings of larva in potato.

j.—Pupa at the end of a tunnel, seen through the potato skin. Somewhat reduced.

e.—Larva or grub, top view. Enlarged.

f.—The same, side view. Enlarged.

g, *h*.—Views of segments of larva. Much enlarged.

i.—Pupa or chrysalis. Enlarged.

l.—The Moth. About three times natural size.

The Pear Slug, *Eriocampoides limacina* Retzius.

(Figs 1, 3 and 4, from U.S.A. Department Agriculture).

1.—Adult female wasp. Enlarged.

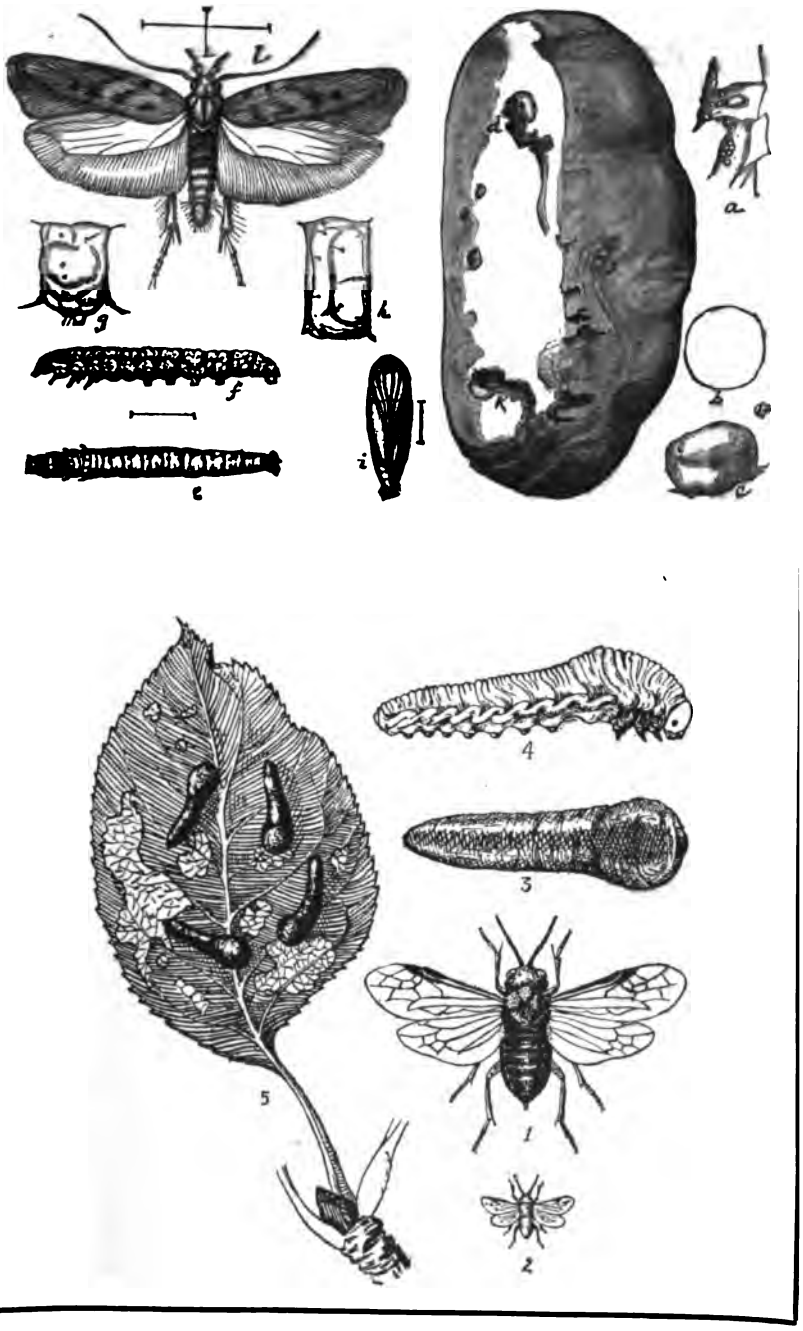
2.—The same. Natural size.

3.—The larva or slug, top view. Enlarged.

4.—Side view of slug after removal of slime. Enlarged.

5.—Pear leaf showing slugs and their work. Natural size.

PLATE VI.



Explanation of Plate VII.

The Blaauw Biesje, *Haltica indigacea* Illig.

1.—Beetle. Much enlarged.

2.—Beetles. Natural size.

3.—Small leaf of tong blaar (dock), viewed from beneath, showing eggs as placed by female beetle and injury to leaf.

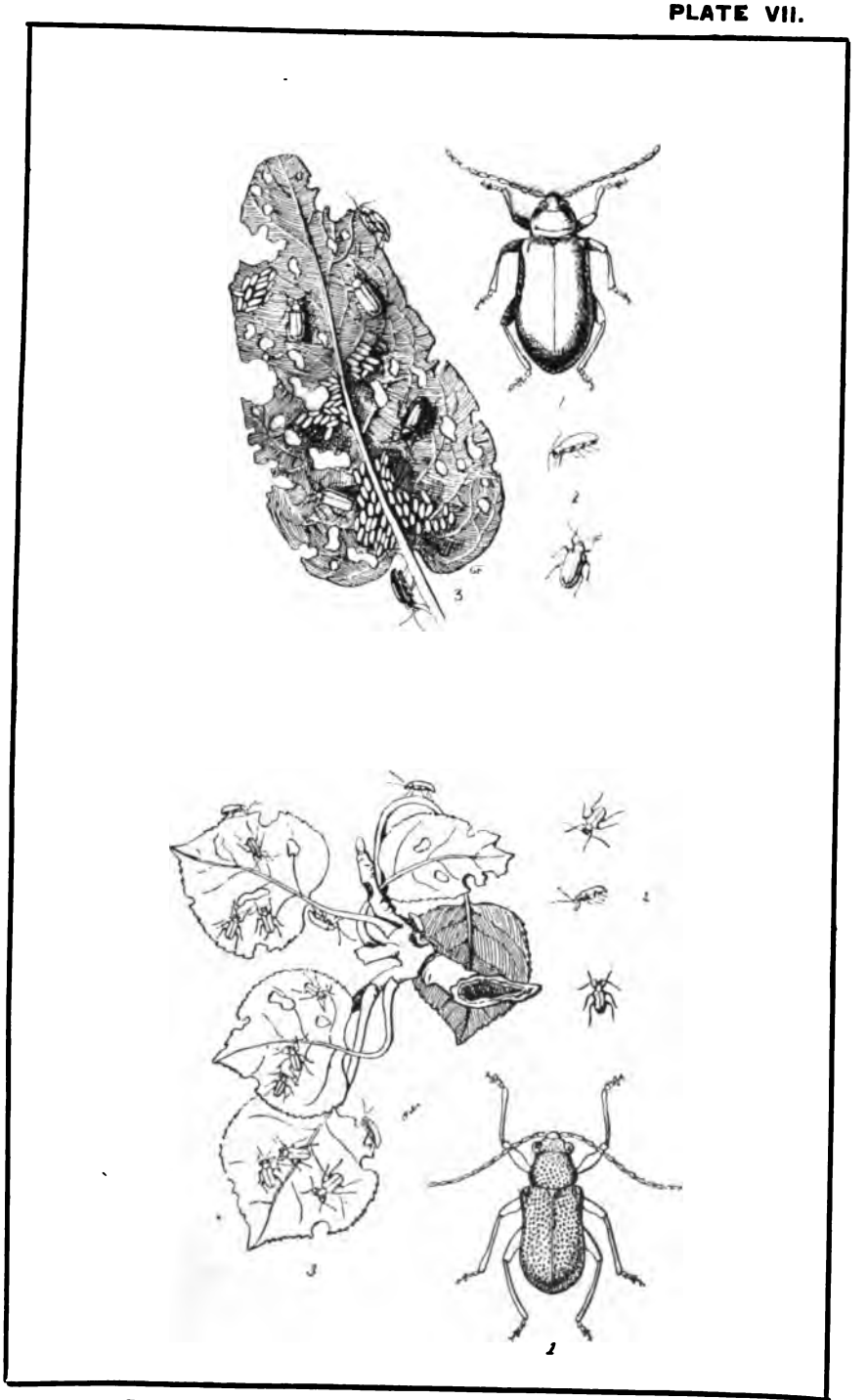
The Odontionopa, *Odontionopa sericea* Gyll.

1.—Beetle. Much enlarged.

2.—Beetles. Natural size.

3.—Twig of apricot to show injury to bark and leaves.

PLATE VII.



Claude Fuller, del.

Explanation of Plate VIII.

1-4—The Calandra, *Phlyctinus callosus* Bohem. Drawn by *Arthur Rich.*

1.—Larva or grub. Enlarged.

2.—Pupa or chrysalis. Enlarged.

3.—Adult calandra. Enlarged.

4.—The same. Natural size.

5.—*Bostrychus cornutus* Oliv. A borer in Bamboo. Drawn by *Arthur Rich.*

6.—A Longicorn Beetle, *Phryneta spinator*, Fab. A beetle which gnaws bark of pear and fig. Drawn by *Arthur Rich.*

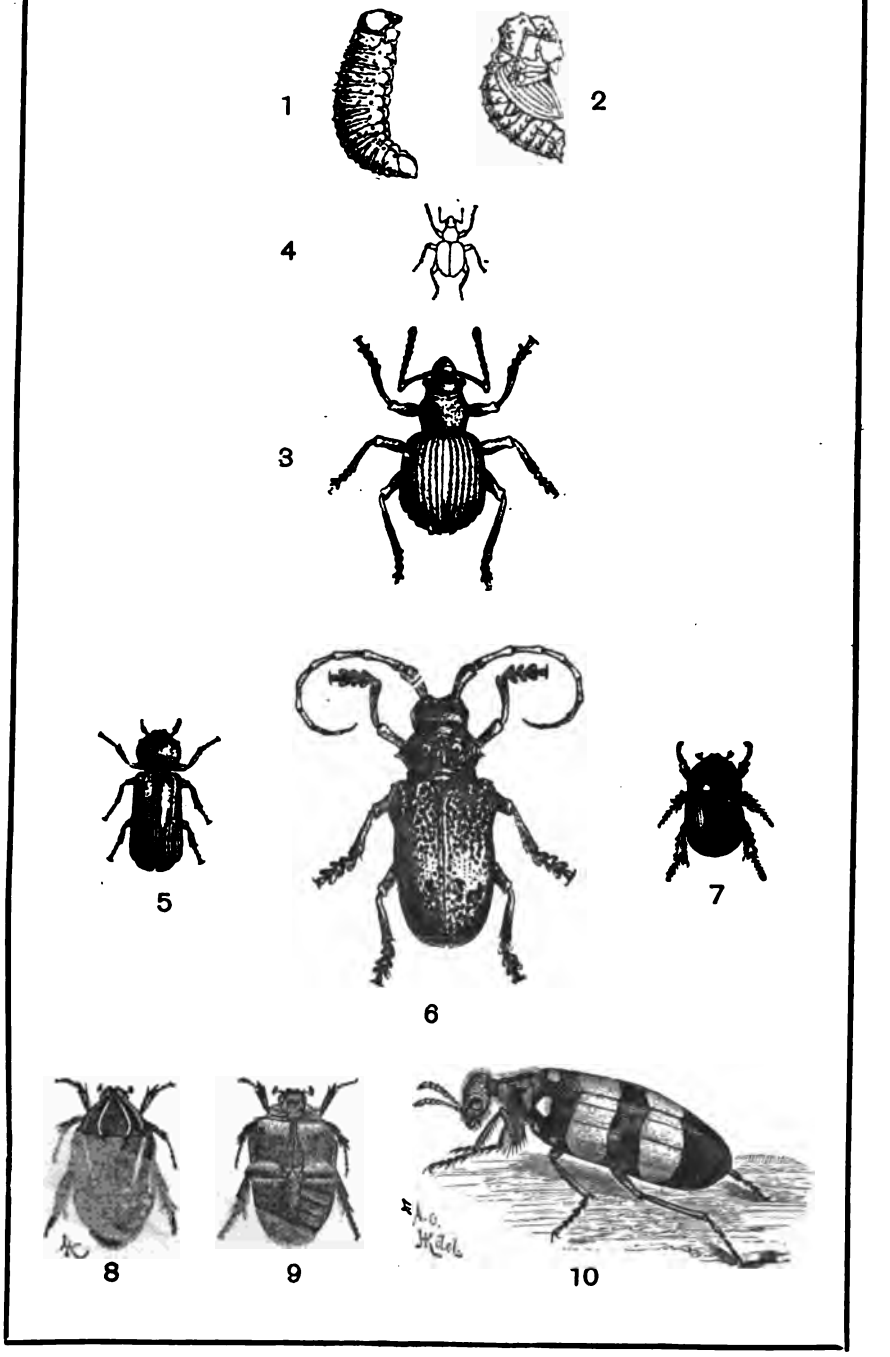
7.—The Keever Beetle, *Heteronychus arctor*, Fab. After *Miss Ormerod.*

8.—The Fruit Chafer, *Rhabdotis semipunctata*, Fabr. A beetle destructive to ripening fruit. After *Miss Ormerod.*

9.—Under side of the same. After *Miss Ormerod.*

10.—Mylabris Beetle, *Mylabris oculata*, Thunb. One of a number of related beetles, closely resembling each other in marking, colours and habits, but differing in size. After *Miss Ormerod.*

PLATE VIII.



Explanation of Plate IX.

1.—The Fowl Tick, *Argas* sp. Magnified 4-6 times.

2.—Larva or young of Fowl tick just hatched. Much enlarged.

3.—Diagrams of mouth and sexual region of the Fowl tick: 1, of the intermediate or nymphal stage showing absence of sexual organs; 2, mouth and just under it at *a*, the sexual orifice of female tick; mouth and external sexual organs of male tick. Much enlarged.

4.—Male Bonte Tick, *Amblyomma hebræum* Koch. Much enlarged

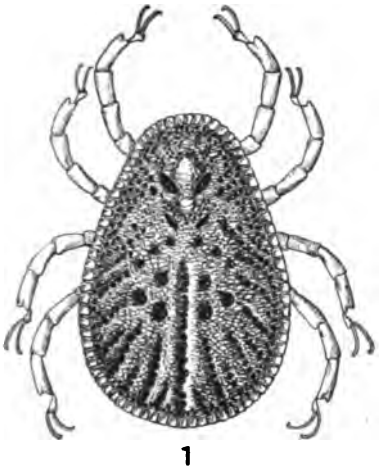
5.—The same. Natural size. After *Miss Ormerod.*

6.—Blue-tick Egg, a few days before hatching, showing development of embryo.

7.—Potato attacked by Gall-worms or Nematodes.

(Figs. 1, 2, 3 and 6, drawn by *C. Fuller.* Fig. 7 by *Arthur Rich*)

PLATE IX.



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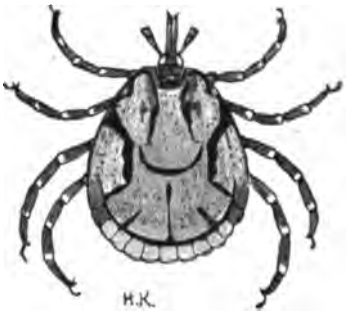

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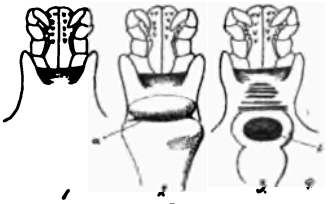

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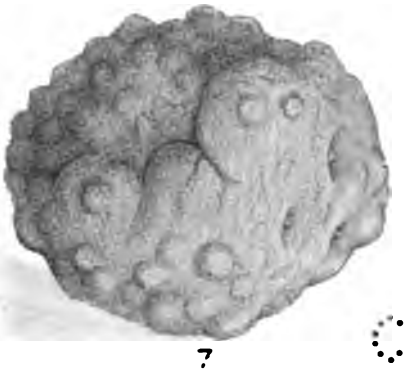

7

UNIV. OF CALIFORNIA

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

YEAR 1898.

CAPE OF GOOD HOPE.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1899.

CAPE TOWN:
W. A. RICHARDS & SONS, GOVERNMENT PRINTERS,
1899.

[G. 49—'99.]

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

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GOVERNMENT ENTOMOLOGIST

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1900.

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1900.

[G. 36—1900.]

A1827. 560.5.1900.

CAPE OF GOOD HOPE.

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1900.

CAPE TOWN:
W. A. RICHARDS & SONS, GOVERNMENT PRINTERS,
1900.

G. 36—1900.] A1227. 350.A.1900.

Cape Town, 26th April, 1900.

THE HONOURABLE THE SECRETARY FOR AGRICULTURE.

SIR.—I have the honour to present herewith my report for the year 1899. There is some difference of opinion as to the object and value of Annual Reports from offices, such as this one, and consequently as to what should appear in them. In my case I deem the object a composite one. I consider that the report should contain, first—an outline of the work conducted during the year under review, and this I have herein attempted under the heading "General Statement"; second, that it should direct attention to and elaborate on public questions in which this branch is concerned: therefore the remarks under "Insect Legislation," to which part of the report, particularly to the paragraphs relative to the Nurseries Bill, I specially invite your notice; third, that it contain notes and observations on the subjects to which special attention has been given. The first two parts are written almost wholly for the information of yourself and members of Parliament; the third part, more especially for farmers interested in the work of the branch, for the immediate information of fellow-workers pursuing similar lines of investigation in other parts of the world, and for our own reference in future years.

CHAS. P. LOUNSBURY, B.Sc., F.E.S.,

Government Entomologist.

TABLE OF CONTENTS.

Letter of Submittal. PAGE.

General Statement 1
Absences on Duty.
Tick Investigations.
Post Office Examinations of Plant Imports.
Visitors to the Office.
Correspondence and Publications.
Contributions to Agricultural Journal.
Distribution of Vedalia Ladybirds.
Introductions of New Ladybirds.
Resignation of Assistant Entomologist.
Resignation of Department Artist.

Insect Legislation :—
Nurseries Bill 6
Unanimity of Fruit Growers, Concerning.
Plan of Bill.
Nurseries the avenue for the dissemination of numerous Pests
Would-be Value of proposed Legislation.
Recommendations should Bill be rejected.

Orchard Pest Bill 9
Classes of Orchard Pests.
Pest-infested Fruit comparable with unclean Nursery Stock.
Plan of proposed Legislation.
Compulsory Clauses.
Would-be advantages of restricting the Sale and Transport of pest-infested fruit.

Import Regulations 11
Outline of Amendments.
Adoption of Regulations in Natal.
Introduction of New Ladybirds 12
Poor Results of past Introductions.
Two Failures this year.
Leis conformis received alive.
Difficulties in providing Food for Leis.
Disease among Larvæ.

"Gas Treatment" Notes :—
Orchard Fumigation 15
Continued Popularity.
Decline of Co-operative Fumigation.
Cloth employed in Fumigation Covers.
Table of Quantities.
Railway Carriage Fumigation 17
Necessity for.
Formaldehyd—valueless as an Insecticide.
Adoption of Hydrocyanic Acid Gas.
Procedure in treating Railway Carriages.
Quantities of Chemicals used to a Carriage.
This Remedy for Vermin valuable, but exceedingly dangerous in Dwellings.

Tick Investigations 19
Objects of.
Importance of Ticks in Colony.
Early Attempts at rearing Ticks a perplexing Failure.
Operations at Adelaide.

Bont Tick, Amblyomma hebræum, Koch 21

PAGE

Conditions necessary for Incubation of Eggs.
Probable Reasons for relative Abundance in Bush Veld.
Vitality of different Stages before Feeding.
Effects of Heat on Metamorphoses.
Duration of Feeding Periods.

Bont Tick and Redwater 24
Strong Indications that it transmits this Disease.

Bont Tick and Heartwater 24
Details of Experiment to ascertain if Association exists.
Difficulties encountered in the Experiment.
Apparent Infection of Animal.
No Reaction with Red Tick.
Expediency of further Experiments.

Bont Leg Tick, Hyalomma ægyptium, Audouin 27
Life Cycle Notes.
Possible Association with Heartwater.
Importance of the Species if such Association exists.
Drought not unfavourable to Welfare.

Red Tick, Rhipicephalus evertsi, Neumann 29
Remarkable Preference of both Adults and Young to certain situations on Host.
Life Cycle Notes.
Moulting Habits peculiar.

Blue Tick, Rhipicephalus decoloratus, Koch 29
A close ally to Böophilus bovis.
Life Cycle Notes.
Peculiar Moulting Habits.
Rapid Development on Host even in Winter.

Other Ticks from Farm Animals in Cape Colony 32
Rhipicephalus capensis, Koch.
Rhipicephalus bursa (?)
Ixodes pilosus, Koch.
Amblyomma devium, the Schildpad Tick.
Onithodoros savignyi, Audouin, the Tampan.

Fowl Tick, Argas persicus 33
The Larva a fixed Parasite.
Nymph and Adult intermittingly parasitic.
Three Moults, not two, as in Cattle ticks.
Egg Deposition alternated with Engorgement.
Man sometimes attacked.
Possible connection with Disease.

Miscellaneous Insect Notes:—

Codling Moth.. 34
Damage greatest early in Season.
Suggestion that it be an old Pest at the Cape.
Localities where known.

Fruit Fly 35
Much less aburdant some years than others.
Reason for Fluctuation not known.
Attempt to carry Adults through Winter.
Prickly Pears infested.
Netting Measure of protecting Fruit.
Bird Netting.

Pear Slug 36
Has reached Worcester.
Insecticides for.

Scale Insects 37
Red Scale in Colony for fifty years.
Fungus to destroy Red Scale.

PAGE

Orthezia insignis at Cape Town.
Thorn Tree Scale in German South West Africa.
Harpuis Bosch Scale and its possible Value.

Fowl Midge, Simulium sp. 38
A newly-discovered Pest to Fowls.
Habits.

Appendix A.—Tick Destruction Experiments.. 40
Cooper's Dip.
Smith's Scrub Exterminator.
Smith's Scrub Exterminator and Sulphur.
Lime and Sulphur.
Soda and Sulphur.
Sulphur.
Paraffin Emulsion.
Paraffin Pure.
Paraffin and Water mixed mechanically.
Soluble Arsenic with Soap.
McDougall's Sheep Dip.

Appendix B.—Nurseries Inspection and Quarantine Bill 45

Appendix C.—The Plant Pest and Diseases Bill 47

Appendix D.—Plant and Fruit Import Regulations 48

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1899.

Presented to both Houses of Parliament by command of His Excellency the Governor.
1900.

Report of the Government Entomologist for the Year 1899.

GENERAL STATEMENT.

The work of the Entomological Office during the past year has been conducted along the lines noted at length in the opening statements of my last Annual Report. Likewise, a corresponding portion of my time, from one-fourth to one-third, has been spent away from the office on investigations, or otherwise engaged in official work. In January a visit to Grahamstown was made in order to read a specially prepared paper at the Farmers' Conference held in connection with the South African Exhibition, and the opportunity was taken to make observations and studies on some of the insects in that section. In April an absence of a week was occasioned by a trip to Kimberley to take part in the proceedings of the Annual Farmers' Congress. Most of the time from middle of May to the latter part of July was spent in the Fort Beaufort Division in connection with tick investigations. A meeting of the Eastern Province Horticultural Board at Queen's Town on July 14th and 15th was attended by request to explain to that Board the various legislation propositions originating with the Western Province Horticultural Board, with which body I am associated as one of the two Government representatives. This trip cost a week's time.

Tick Investigations.—The tick investigations at Fort Beaufort were conducted at "Cottesbrook," with the gratuitous but invaluable assistance of Mr. L. J. Roberts, the owner of the farm.

These investigations with studies conducted in continuity of them at Cape Town constitute the most important work accomplished during the year outside from the routine duties. The life history of the notorious Bont Tick has been fully elucidated, and the life histories of other injurious species partially traced. Details will be given under a special heading later on in this report. It was incidentally discovered during the studies on the Bont Tick that it was capable of transmitting redwater, a cow infected with the ticks becoming diseased. An experiment to determine if this tick, or the Red Tick, served as a conveyor of heartwater from beast to beast was conducted towards the close of the year at the cost of considerable time and trouble. No symptoms of disease at all were manifested by the animal—a goat infected with the Red Tick; but in from three to four weeks from the time of infection with the Bont Tick, the second goat experimented with was seized with high fever. Its temperature bordered on 107° for about forty-eight hours, and then within a similar period sank to the normal. It is presumed that the animal suffered a mild attack of heart-water. While at Cottesbrook the opportunity was taken to experiment with different promising substances, for the destruction of ticks infesting horned cattle, by their application in the form of a spray. A report on these experiments was made to Dr. Hutcheon, the Colonial Veterinary Surgeon, for his information, as measures for the destruction of ticks have long engaged his attention, and therefore may be held to more properly fall within the province of his department than mine. For reference a copy of the report is, however, included here as an appendix.

Post Office Examinations.—During the year, one hundred and seven parcels containing plants or vegetable produce subject to the restrictions imposed by our Import Regulations were submitted to me for examination by the Superintendent of the General Post Office. In four of these were found plants or parts of plants, the introduction of which is prohibited. Four contained apples from England infested with the Oyster Shell Bark Louse (*Mytilaspis pomorum*), a highly pestiferous scale insect that has not yet become established at the Cape; in no case were the fruits badly infested, and after the insects had been removed from them they were allowed to pass. Two parcels of bulbs from England contained aphides, and were fumigated. One parcel contained *Lecanium hesperidum* on rose cuttings. Four parcels of very small Otaheite orange trees from a New York nursery were found to be infested with a scale insect determined as a species of *Parlatoria*; these were thoroughly disinfected and allowed to be delivered. One parcel of fifty or more apple scions for grafting purposes from Ireland for a Cape Town party was found to contain, in nearly every scion, specimens of the Oyster Shell Bark Louse and

numerous eggs of the Apple Aphis (*Aphis mali*). All of the scions were destroyed by burning. A package of currant and gooseberry cuttings from the South of England addressed to a resident of the Paarl district was similarly disposed of; several slugs were found in the box, probably introductions with the packing material, and young specimens of the Currant Scale (*Lecanium ribis*) as well as eggs of the Currant Aphis (*Aphis ribis*, Linn.) were detected on nearly every cutting. Nor was this all, for several specimens of a lepidopterous larva, presumably of *Sesia tipuliformis*, Linn. were found boring in the stems. Doubtless, the senders of these apple, gooseberry and currant cuttings failed to notice any of the insects they were enclosing, and, truth to tell, the cuttings would all have passed for clean if not minutely examined. The presence of the borers was barely indicated on the surface; and both the scale insects and aphides, though numerous, were hidden from the front by the projecting buds, scarcely one of which did not shelter aphis eggs. A number of boxes of lemons from the Holy Land addressed to Hebrews in various parts of South Africa were found to be more or less infested with several species of scale insects, including two unknown here; but on ascertaining that the fruits were for use in synagogue rites, and that the chance for them infecting growing plants was not worthy of consideration, the boxes were allowed to go forward without contaminative handling. Each fruit in these boxes was separately rolled in many yards of hemp fibre, and therefore to unpack and repack the boxes, as would have been necessary were the fruit fumigated, would have proved a tedious task.

Visitors to the Office.—Much time has been given to visitors to the office in quest of information concerning insects or insecticidal measures. The time thus expended is not productive of tangible data for the yearly report, but is deemed to be well spent. The number of visitors has increased steadily from year to year, and is a sound indication that the work of the office is becoming more widely known and appreciated.

Correspondence and Publications.—The correspondence of the office shows a slight falling off during the year, one indirect result no doubt of the distraction from ordinary affairs caused by the military operations in the Colony. Eight hundred and eighty official letters were written, and a few over eight hundred received. As in previous years no account has been kept of the frequent letters and reports that have been dealt with through the formal departmental channel.

The contributions to the *Agricultural Journal* have been as follows:—

Title.	Illustration.	Form.	Issue.	Pages.
				Vol. xiv.
*A New Poultry Pest. *Simulium sp.*	Seven; all original	Article	January 5	29-35
*The Harpuis Bosch and its Natural Enemy	Four; all original	Article	,, 19	93-6
Insect Pests: Their Origin, and Means for Their Suppression	..	Article	February 2	160-76
The Wattle Bag-worm ..	Five; all original	Article	,, 16	211-5
Pig Lice *alias* Tampans ..	..	Letter	,, 16	240
Codling Moth Again ..	..	Article	March 2	285-88
Woolly Aphis	..	Note	,, 2	288
*The Common Blue Tick of Cape Colony	Eleven; all original	Article	,, 16	363-9
The Harpuis Bosch and its Enemies	..	Letter	June 8	818
				Vol. xv.
*Insect Friends and Foes ..	Eleven; seven orig'l	Article	July 20	100-9
Winter Spraying	..	Article	August 17	267-71
Ants	..	Letter	,, 17	283-4
Bagrada Bug	..	Letter	,, 17	285
Fruit Fly	One	Article	September 14	413-7
Tampans or Fowl Ticks ..	Two; both original	Letter	,, 14	421-2
Cabbage Aphis	One	Letter	,, 14	423-5
Bean Bruchus	Two	Letter	,, 14	425-8
Woolly Aphis or American Blight	..	Note	October 12	541-2
Ants	..	Letter	,, 26	601
Spraying Locusts with Paraffin	..	Letter	,, 26	602
Aphides on Peach Trees ..	..	Letter	,, 26	602-3
Codling Moth	..	Note	November 9	659
Grain Bug	..	Letter	,, 9	664
Codling Moth	..	Letter	,, 9	664-6
Bagrada Bug Again.. ..	One; original ..	Letter	,, 9	666-7
The Bont Tick. *Amblyomma hebræum*	One	Article	,, 23	728-43

* Written by Assistant Entomologist.

These contributions covered eighty-three pages of letter-press. Forty-six illustrations were used, thirty-seven of which were original and from drawings prepared at this office. A profusely illustrated placard cautioning fruit growers with regard to the Codling Moth was published in March at the suggestion of the Western Province Board of Horticulture. English and Dutch copies were posted in the Railway Stations and most of the Post Offices throughtout the Colony, and these still remain to direct attention to this destructive insect. A revision of the "Table of Quantities," a statement in tabular form of the quantities of the respective chemicals recommended for the fumigation of citrus trees, was issued in May. This table is printed on heavy card and

beneath in a concise form are given all the necessary directions for fumigating. It is designed that parties fumigating trees have these cards by them in the orchard as a guide and reminder, and the purpose is well served.

DISTRIBUTION OF VEDALIA.—The duty of procuring Vedalia ladybirds for colonization in sections in which the Australian Bug has appeared in threatening numbers devolves upon me. Forty odd sendings were made during the last twelve months, the majority of these going to parties resident in northern parts of the Colony. None of the outbreaks of the Bug this year are known to have been of any great extent, and doubtless most were limited to single gardens the owners of which became needlessly alarmed. With each year, it becomes increasingly difficult to secure Vedalia and determined efforts to collect a sufficient number for a single sending have been unrewarded for days together. Nevertheless, the Australian Bug is always present in all the suburbs of Capetown. Nearly every plumbago hedge is infested to at least a slight extent; but, curiously, the Vedalia rarely attacks its prey on this plant, leaving it there to the attentions of other and less efficient species of ladybirds. The hedges serve as a breeding ground for the Bug and as summer advances it spreads to surrounding vegetation, there soon to be suppressed by the Vedalia.

INTRODUCTION OF NEW LADYBIRDS.—Attempts at introducing beneficial ladybirds from abroad continue to be made, but as was remarked in last year's report, the chances for effectually establishing exotic species are slight unless we have a qualified agent travel to collect the desired kinds and to bring them to the Cape, or to send them in competent charge, in very large numbers of each kind. This year three small sendings were received through the kindness of Australian friends. Detailed mention of these will be made on a future page and I need only record here that the attempts were unavailing.

RESIGNATION OF ASSISTANT ENTOMOLOGIST.—The plans for season's work was disarranged through the resignation of the Assistant Entomologist, Mr. Claude Fuller, F.E.S., in the middle of the year. Mr. Fuller left to become Government Entomologist of Natal. His selection for the post—a new one, in preference to other and older applicants reflects much honour upon this office; and although the sudden termination of his engagement with this office considerably embarrassed the work, I was heartily pleased, in token of my esteem for his welfare and confidence in his abilities, to recommend him to the Natal authorities and to assist him in securing his release from the contract with this Department. His familiarity with the aims of this office and of the Cape conditions are now aiding in rendering him an invaluable correspondent, and in many ways we are a mutual advantage to one

another. The vacancy caused by Mr. Fuller's withdrawal has been filled by the appointment of Mr. C. W. Mally, M.S., who took up his duties here about the middle of February. Mr. Mally comes from the State Agricultural Experiment Station of Ohio, U.S.A., where he was Chief Assistant to Professor F. M. Webster, one of the foremost of American economic entomologists. Incidentally, it chances that Mr. Mally passed his youth on an Iowa farm, and as Iowa is one of the four great corn (mealie) raising states, he will doubtless be able to favour the Colonial farmers with whom he comes in contact with much valuable information on the American methods of growing and utilizing this invaluable crop. Despite of high priced labour and numerous destructive pests, the American farmers contrive to grow mealies profitably at a fraction of the expense incurred in the Colony.

Resignation of Department Artist.—The resignation of the Department Artist, Mr. Arthur Rich, has also affected the work of my branch. I had planned to have this report contain many illustrations from drawings by him, including a coloured plate depicting the various important stock-infesting ticks, but have had to relinquish the idea. The services of an artist is a pressing need.

My report for the year could, with propriety, be terminated here, but in accordance with the precedent of the preceding years, I shall supplement this general statement of the year's operations with remarks on several pertinent subjects and extended consideration of the more important work in progress or accomplished.

INSECT LEGISLATION.

The subject of insect legislation for the protection of horticultural interests will be given a prominent position in my annual reports until we have acceptable measures enacted, or until the matter loses its interest entirely to progressive fruit growers. As in the last report, the three phases of the subject will be dealt with separately.

The Nurseries Bill.—No attempt was made by the Government to introduce the Nurseries Inspection and Quarantine Bill during the past session of Parliament, but the Horticultural Boards have a promise that it will not be so neglected at the next session. The Eastern Province Horticultural Board is now at one with the Western Province Board in support of the present draft bill, hence the measure may be said to have the support of the majority of the fruit growers throughout the whole Colony. The draft is essentially the same as has been urged for three years, and for convenience the full text is given in an appendix. The scheme is that a Government officer inspect all plant nurseries twice a

year, and then place in quarantine all nursery stock within a definite distance of plants found infested with proscribed noxious insects and plant diseases, and that such quarantine remain in force until at a subsequent inspection the pests are found to have been eradicated. Examinations by request between the regular inspections are provided for to lessen the possible hardships of the legislation. The object of the legislation is to restrict to the maximum degree practicable the dissemination of pests from nurseries, and to there detect and, if feasible, to eradicate newly-introduced pests; and it is desired to accomplish these ends with the least possible trouble to the nurseryman compatible with success. I urge the importance of the proposed legislation, and announce that I am unqualifiedly in favour of it.

Numerous are the orchard pests that have been, or most probably have been, introduced into the country by the nurseries, and it is at least chiefly from such sources that our scattered farmers have received and continue to receive, unwittingly the insects and plant diseases that so increase their expenses for growing fruit. True it is, that these pests may spread from orchard to orchard either through the instrumentality of their own locomotive functions or other agencies equally beyond our control, but my knowledge of our present worst orchard pests and those which we are in most danger of introducing gives me ample ground for emphatically asserting that nearly all are such as spread very slowly when left to themselves; to spread to a neighbouring farm or even, in some cases, to the next tree may take several years.* On the other hand, along with nursery stock, the same pests may be introduced to and become established in an unlimited number of orchards within the confines of a single season.

The value to the individual fruit grower of legislation such as is proposed must vary with the distance which separates his orchards from possible sources of contamination through other means than nursery stock and with the condition of his orchards as regards the classes of pests that would be affected. The orchardist who must make use of insecticides because of pests already established has, naturally, far less cause to dread the introduction of a new pest that can be controlled wholly or to a large extent by the measures he practises than an orchardist whose trees require no insecticides for their protection. Likewise the man whose orchard is closely surrounded by gardens in which pests are rife has not altogether the same need to insist on his getting perfectly pest-free trees from the nursery as the man whose orchard is remote from others. It follows that, relatively, nursery legislation should prove of greater benefit in parts of the Colony where

* These remarks are not meant to apply to the Codling Moth, Fruit Fly or Pear Slug; these pests are very unlikely to be disseminated with nursery stock and hence do not call for consideration here.

fruit growing is a new industry than in the older parts like Stellenbosch and the Cape, for instance, where many of the pests most feared are already widespread and where the farms are small and orchards often contiguous. There is, however, no part of the Colony, in my opinion, that would fail to benefit by the enactment and enforcement of the proposed legislation, not even the suburbs of Capetown—a continuity of gardens with shrubs and fruit trees encrusted with scale pests, the equal of which, for quantity and variety, would be difficult to find anywhere on earth. Yet even about Capetown trees planted free of scale frequently remain so for many years.

In the course of time all necessity for nursery legislation may perhaps die away through the uniform occurrence of all the insects legislated against. Do what we will, the pests will spread to the utmost limits of the areas favourable to them. The most drastic and fully enforced legislative enactments will not wholly hold them back; no, not even if supported by earnest efforts on the part of the public for which we have no reason whatever to even hope. But the retardation of this irrepressible spread will tend to minimise the injuries the pests inflict since we are continually improving the means and devices for contending against plant diseases and insects, and slowly accruing knowledge of natural enemies of the latter that must prove of immense advantage in hastening the restoration (as far as may be done) of the so-called "balance of nature,"—that equilibrium between plant and animal life that man has incidentally disturbed by his selection, cultivation, and dissemination of forms of life suitable to his progressive requirements. Moreover, many scientists claim as an established fact that with the lapse of years, most pests lose, in part through the increase of natural checks, but more, it is thought, through other and more obscure factors, the aggressiveness and destructiveness that characterised them as recent introductions. For these reasons, it behooves us as a progressive people to exert ourselves in reasonable manners to retard the dissemination of orchard pests, and the proposed legislative enactment to retard the spread of pests with nursery stock is a *most* reasonable manner.

Our colonial conditions, climatic and otherwise, have proved most favourable to the multiplication of several highly injurious introduced pests; and we have every reason to believe that many pests yet awaiting introduction or yet awaiting general dissemination will find the conditions equally propitious. It is sometimes asserted that as we have so many orchard pests generally disseminated, it is practically needless to guard against the spread of others. I maintain otherwise. No pest, new or old, should be ignored on nursery stock for planting; and the introduction with young trees of any new pest, even of a kind closely related to a species well established in the orchard in which

the planting is done, may prove expensive folly. For illustration, let us consider a case. Few citrus orchards in the whole Colony are now free of the Red Scale (*Aspidiotus aurantii*), a scale pest by the way as destructive as any of which we stand in danger. Hydrocyanic acid gas fumigation holds this insect in check and is now widely practised. Now we have another scale of citrus trees, the Purple Scale (*Mytilaspis citricola*); its occurrence is still limited but it is known to infest several orchards and at least two where nursery stock is grown for sale. This purple scale likewise yields to hydrocyanic acid gas. Therefore it looks at first sight as if its dissemination is of little or no account when it goes to orchards where Red Scale exists. Yet it may be of serious account. The Purple Scale will work on trees along with the Red; it multiplies on the naartje, a tree for which the Red has little liking; it has an egg stage of several weeks' duration during which it fails to succumb to gas at the strength safe to use on citrus trees; and lastly, it thrives under seasonal conditions adverse to the Red Scale. All in all then, to combat the Purple with the Red costs much more than to combat the Red alone. Similarly in numerous instances that might be cited, duplicature of the species of scale or other pests augments the expense of protecting fruit trees even when the same remedies answer for both the new and the old. Should the Nurseries Bill as it stands fail to secure sufficient support in Parliament to make it become law, steps should *at once* be taken to urge a modification of it that *will* find support. With each year of no effective legislation the evil to be remedied increases; and while I believe a measure involving quarantine of pest-infested sections of nurseries would best safeguard the interests of the fruit grown and prove easily workable, I am of the opinion that material benefit could be derived from even a measure only demanding the fumigation in an effective, prescribed manner of all nursery stock as it leaves the nursery and such a measure as this would meet with few objections from our nurserymen. Neither would much objection be raised to a periodical inspection of all nurseries by a Government officer having a knowledge of insects and diseases liable to be spread with nursery stock, if such inspections were to be conducted solely to acquaint the nurseryman with the pests present on his grounds; and if thus made cognizant of the pests and informed how best to treat them, the majority of nurserymen would take immediate steps to remedy matters.

Orchard Pest Bill.—The pests which are spread in a wholesale manner from nurseries tend to spread slowly from orchards in which they become established. Then there are other orchard insect pests that rarely if ever spread with nursery stock but which spread more or less freely from farm to farm by virtue of their wing power; such is the Pear Slug. Then there is a third

class which may fly from farm to farm but which may be disseminated in a wholesale manner by accompanying consignments of fruit; such is the Codling Moth and the Fruit Fly. In so far as the the third class of the pests is concerned, the fruit grower plays a part analogous to that played by the nurseryman in the dissemination of pests that spread with nursery stock. And if legislation to restrict the dissemination of pests with nursery stock is just, which has been contended at length, so is legislation to restrict the dissemination to new localities of this class of pests through the agency of fruit. As regards the first two classes of pests, there is much less need for legislation, and except in strictly fruit growing sections of the country, legislation for their control seems not only unnecessary but actually undesirable, among other good reasons because the expense of enforcing effective legislation would be entirely disproportionate to the benefits derivable.

The Western Province Horticultural Board discussed orchard legislation early in the year under review, and appointed a committee of which I was a member to formulate propositions. A draft measure was prepared in April based to a large extent on the 1895 Plant Disease and Insect Pest Bill, but up to the first of the year the Board had neither agreed on the text nor attempted to amend it to meet the views of its majority. The Eastern Province Horticultural Board, however, gave its approval to the draft in July last, but did so under the impression that the other board supported it and with the realisation that in such a case opposition on its part would seriously retard the presentation of the measure to Parliament. [The Western Province Board has finally, on April 12th, formally approved of the draft after making several slight modifications. In the amended form, the text is included in the appendix of this report.]

In agreement with the ideas phrased or implied in the rough classification of orchard pests made above, there are both compulsory and permissive features in the proposed legislation. The formation of local "horticultural commissions" is provided for in districts or wards of a district in which the *bonâ fide* fruit growers, by a majority, request the enforcement of the permissive clauses. These local commissions are empowered to have all the properties within the area for which they are appointed inspected to ascertain their condition as regards insects and plant diseases deemed pestiferous, and to compel occupiers to apply prescribed remedies for such evils should they be considered a public menace. There are two compulsory sections in the Bill: One authorising the Minister for Agriculture to have action taken to suppress any exceptionally injurious pest of limited distribution in any district; and the other prohibiting the transport in public conveyances and the sale in public markets of disease and insect infested fruit. [In the amended form the restrictions apply only to fruit infested with Codling Moth or with living scale.]

To my mind, the most important feature of the Bill is the compulsory clause restricting the transport and sale of pest infested fruit, and if this clause is enacted and discreetly enforced, our fruit growers of the progressive sort should reap many advantages. These three important effects might be expected to follow:—

1. A diminution in the rate of spread of the pests concerned to new centres.
2. A decided increase in the efforts to cope effectively with orchard pests. Negligent and retrogressive parties who have fruit to dispose of (the term "fruit-growers" seems inapplicable to those who only gather and sell fruit that trees on their farms chance to produce) will find that to longer realise a profit they *must* apply proper remedies, and the result will be a benefit to themselves along with their neighbours.
3. The quality of the fruit sold in the markets will be improved; this will promote the consumption of fruit, and will tend to increase the profits of fruit culture by the prevention of gluts. Inferior qualities of fruit not only often drug markets, but generally depress the return for superior fruit.

The chief objection to the proposed restriction on the sale of fruit seems to be that fruit-growers fear that doing the best they can they will still produce large quantities of pest-ridden fruit. But should fruit growers be thus unfortunate, the inferior fruit need not be wasted. It may be fed to animals on the farm, sold locally at retail, converted by drying or other means into a marketable form, or transported in private conveyances to jam or curing factories. The primary intention of the restriction is to check the dissemination of the infesting pests and the disposal of the inferior fruit in any of the ways suggested would not be materially antagonistic to this object.

Import Regulations.—The proposed changes in the regulations governing the introduction of foreign grown plants and fruits discussed in last year's report are at last in a fair way to adoption. The text of the proposed schedule, amended to the time of writing, will be embodied as an appendix. In the new form the regulations should prove more serviceable, and are not expected either to deleteriously interfere with plant culturists in the Colony or to prove difficult to effectively enforce. The importations of fruit trees will be limited to new varieties and these will only be allowed entrance in small numbers and under special permit. The wisdom of this restriction is questioned by a certain section of Eastern Province fruit-growers on the ground that the colonial nurserymen thus receive unwarranted protection from foreign

competition. But in addition to the indisputable fact that the introduction of foreign grown trees in quantities is attended with grave risks, it may be said in support of the restriction that the colonial nursery business has reached a stage at which honest competition within our borders is sufficient to guard against exorbitant charges. The colonial nurseryman cannot afford to sell his trees at the low rates current in Australia and America; but, all the facts considered, colonial grown trees from a high-class nursery at colonial prices are far preferable for the South African farmer to foreign grown trees of the same varieties, at the lowest cost at which it is possible to land them.

Thanks to the earnest efforts of its Entomologist, Mr. Claude Fuller, Natal has at last adopted plant import regulations, and thus an important safeguard is secured to us against the importation of foreign grown trees through Durban and thence overland.

INTRODUCTION OF NEW LADYBIRDS.

One of the minor but most worrisome matters to which attention was given during the year under review, was the attempted establishment of a beneficial ladybird from Australia. Other attempts in former years all appear to be without permanent results, and the efforts have been continued in full appreciation of the fact that success at the best is a matter of slim chances. The stakes to be won, however, seem sufficient to justify the continuance of the operations in a limited way despite the numbers of successive failures. Last year the successful introduction of one of the ladybirds (*Exochomus nigromaculatus*) to Ceylon was chronicled, and the fact that this species steadily though slowly increases in its new home cheers us in attempting further import ventures.

Three lots of ladybirds were received and all came from Australia. The first to arrive came by the "Aberdeen" during February, and consisted of about one hundred and twenty-five *Orcus chalybeus* beetles. This species is one we are specially anxious to see established at the Cape and it preys upon the kinds of scale insects that give us greatest trouble. The Government Entomologist of New South Wales, Mr. W. W. Froggatt, favoured us with the collecting of the insects and they came in the personal charge of the captain of the vessel, who at our request on his previous trip to the Cape had courteously agreed to assist in this manner. It was intended to have the insects stored in the cool room of the vessel, thus to keep them practically dormant; but unfortunately the cooling apparatus became disordered and in consequence they travelled in a cool place on deck. The warmth in the latter situation was sufficient to keep the insects active; they

soon exhausted their food supply, and then succumbed to starvation. One beetle alone reached Cape Town alive, and this was a male. An equally unfortunate sending arrived in charge of the captain of the "Warrambool" in December. It consisted of about one hundred specimens of *Leis conformis*, collected and despatched by Mr. Richard Weir, a Cape Colonist, studying at the Hawkesbury Agricultural College, New South Wales. The sending that remains to be mentioned was also of *Leis conformis*, which is a relatively large ladybird reported to be of great value in Australia as an aphis destroyer. This lot came in the early winter, reaching here on May 16th. It was secured through the kindness of Mr. A. Le Souëf, Melbourne, Victoria, and the case was entrusted to Captain Simpson of the "Moravian." Every one of the hundred or more beetles comprised in the sending was alive on arrival. All were practically dormant, which is believed to account for their satisfactory transit. The voyage was of four weeks' duration. Food was placed within reach and renewed at frequent intervals but for several weeks none of the ladybirds manifested much desire to feed. They clustered in a dark corner of their cage and remained motionless except when the thermometer registered about seventy. When the temperature mentioned was reached most of them would wander about and eat sparingly, but when it grew colder again all would retire to their secluded corner. Few would remain out when the temperature fell to sixty degrees. An unseasonably warm spell in July brought their hibernation to an end and they became exceedingly voracious. They were found to relish Orange Aphis greatly, and for a few weeks there was no difficulty in procuring them this food in abundance. The sexes mated and eggs in clusters of 10 to 50 began to be obtained almost every day early in August. As a precaution against mishaps, the beetles were divided into lots of about a dozen each, and each lot given a separate box. Fresh food was supplied every other day, and every morning the eggs were removed and placed in separate boxes. It was necessary to isolate the eggs daily, as the adults were found liable to devour them even when plenty of aphis was present; likewise larvæ, when at all crowded, did not hesitate to attack and devour one another, and many just escaping from their egg shells fell victims to slightly older companions. A surplus of aphis was insufficient to prevent such seemingly unnatural attacks. Soon there were several hundred larvæ to feed; but, most unfortunately, with the increased demands for Orange Aphis came a sudden shrinkage in the quantity obtainable. The torrential rains during the first half of August effected an almost complete suppression of this and all other aphides in the vicinity of Cape Town. Not a single aphis could be found on scores of orange and lemon trees that a few weeks before had been perfectly black with its kind. Nevertheless, by patient search over an extended area, the necessary

supply of aphis was continued, though in a drenched and probably unhealthy condition. Ultimately, a few aphis infested trees in the shelter of a building were discovered, and from then (September 1st) the food supplied was ample and presumably entirely suitable. However, the *Leis* larvæ did very poorly. Every one of batch after batch died when a fortnight to eighteen days from the egg. It mattered not whether they were kept in jars, paper boxes, wooden boxes, or gauze cages, nor whether they were fed daily or every other day, nor whether the debris was removed each day or not, they each and all ceased feeding and died during the fateful third week. It was observed that a similar mortality was taking place among the larvæ of the native ladybird, *Oenopia cinctella* Muls., that were somewhat common on the trees from which the aphis-infected twigs were cut, and it is surmised that a contagious disease was responsible. Four years ago a colony of *Leis* was carried through one generation without any difficulty, but in the second generation, every larva died, as in the present instance. At the time, it was thought that a change of food, unavoidably made, was the cause of the disaster; but as a large number of the beetles and larvæ had been liberated, and all of these disappeared from notice at about the time those in confinement died, it is not improbable that all succumbed to a disease. After the lapse of about six weeks from the time they began, the old ladybirds almost ceased to lay eggs, and in the hope that they might continue to lay if placed under perfectly natural conditions, they were liberated on an aphis-infested tree. Two weeks later, (September 26th) all the larvæ remaining alive, two to three hundred in number, were also liberated, there appearing to be then little chance of maturing any in captivity. A couple of beetles were found on the tree six weeks later and raised the hope that enough of the insects had survived to prevent the colony dying out; but since December, none has been observed, and all the trees in the vicinity have become free of aphis. That all of the colony has now perished is deemed almost a certainty since it is highly improbable that after scattering to find food the few survivors could have been successful in mating.

Before the heavy rains in the beginning of August, when the Orange Aphis was so exceedingly abundant, there were present on the infested trees an immense number of the Yellow Ladybird *Oenopia cinctella* Muls. This ladybird feeds ravenously on aphis, and, in the Cape and neighbouring districts, remains active throughout the winter. It was ovipositing freely during late July and when the heavy rains came on the foliage of the trees was well spotted with the yellow egg clusters. The clearance of the aphis by the rains brought the parent insects to the verge of starvation, and scores were observed to feed on their own eggs. The larval insects, likewise starving, roamed about in search of stray aphides,

and individuals were time and again seen to suck the juices of their kindred. In a few weeks the species had almost vanished. Doubtless, the *Leis conformis* beetles and larvæ would have been similarly preying on their own kind had they not been kept in confinement and well supplied with aphis, and as their numbers were limited they would have quickly brought their colony so near to the verge of extinction that further propagation would be rendered improbable.

Aphides are always subject to extreme variation in numbers. Not only may storms suddenly quite exterminate a species in any particular locality, but most tree infesting kinds only thrive on new or succulent growth of their food plants and when this growth hardens with the advancing season, the aphides must nearly all perish. To make certain of the establishment of a ladybird dependent on aphides, as is *Leis conformis*, it must be introduced in great numbers in order to off-set the impairing influences of these fluctuations in its food supply. There are chances for success in the case of very limited numbers but these wholly depend on the very precarious factor of ample food close at hand until, by propagation, the colony has become strong enough numerically to be able to withstand a wide dispersal of its members. Should the efforts to establish *Leis conformis* in South Africa be ultimately successful, the dissemination of the insect through the country would have to be largely the natural spread of the foundation colony; its rapid dissemination by means of small secondary colonies would be impracticable.

"GAS TREATMENT" NOTES.

Orchard Fumigation.—Fumigation with hydrocyanic acid gas continues to be considered the most satisfactory remedy for the Red Scale throughout the Colony. The only assistance the Government now gives to growers to encourage the employment of the remedy is the sale of cyanide at cost price; this assistance will probably continue to be necessary for an indefinite period as sufficient quantities of the chemical to admit of merchants buying in large bulk and selling at low rates are not used by the farmers.

Co-operative fumigation, it is slowly becoming evident, will in time give place largely to private fumigation. This I consider unfortunate but under our conditions it is scarcely avoidable. Only in districts where orangeries are numerous and within easy distance of one another does it seem probable that co-operative fumigation will hold its own. After witnessing the operations a few times, most fruit growers with large holdings become possessed of the desire to own covers of their own that they may

be independent of neighbours and able to treat their trees at any time scale is observed. The work in these holdings lost, the co-operative outfits have less to do, the average expense per tree increases and gradually the outfit falls into disuse since it no longer pays to keep a skilled operator in charge. Thus parties who cannot afford the private ownership of apparatus lose the opportunity of benefiting by the treatment.

Most of the fumigation covers used are supplied by Messrs. James Robertson & Co., Plein Street, Cape Town. No. 8 American duck of the best quality is usually employed in making the covers for trees up to ten feet in height, and No. 10 duck of the same quality in making those for larger trees. Willesden rot-proof, water-repellant, sixteen ounce duck is regarded as a somewhat better material for covers by those who have used it, but its few advantages seem insufficient to offset the extra cost at the present rates.

The following amended "table of quantities" was issued in May last. Copies on cardboard are sent to intending fumigators on application.

Height.	Diameter.	Water.	Acid.	Cyanide.	Space enclosed.
Feet.	Feet.	Fluid oz.	Fluid oz.	Oz.	Cubic Feet.
4	3	½	½	¼	(25).
6	4	1	½	½	(65).
6	6	2	1	1	(140).
8	6	3	1½	1½	(200).
10	8	5	2½	2½	(435).
12	8	6	3	3	(535).
12	10	7	3½	3½	(815).
14	10	8	4	4	(970).
14	12	10	5	5	(1,355).
16	12	12	6	6	(1,585).
16	14	15	7½	7½	(2,105).
18	14	16	8	8	(2,415).
18	16	20	10	10	(3,085).
20	16	22	11	11	(3,485).
20	18	26	13	13	(4,325).
22	18	30	15	15	(4,835).
24	20	40	20	20	(6,500).

In framing this new table, the area of the surface through which the gas may escape and the cubic content were both considered. Less chemicals by one-fourth, or even one-third, may be taken for trees under 14 feet, if heavily oiled covers are employed, or if the trees are scantily foliaged and not badly infested with the scale; but, except when the trees are found to suffer severely, it is suggested that the quantities scheduled be used. If the acid and water are mixed, always pour the acid into the water, not the water into the acid, and use the mixture before it has lost all of its heat.

Railway Carriage Fumigation.—The conditions of travel in South Africa, private bedding and long journeys, so favour the introduction and multiplication of man's most persistent nocturnal visitor, the bed bug, that the railway saloon carriages on the Cape Government Railways, particularly those for second and third-class passengers, have long borne a rather unsavoury reputation. The officials in charge of the rolling stock were not indifferent to the comfort of passengers, but their efforts to suppress the pest were for long wholly unavailing. Correspondence with railroad managements in other parts of the world was finally engaged in, but elicited no more hopeful suggestion than to expose the infested carriages to formaldehyde gas. The local office for recommendations and suggestions relative to insecticidal matters was quite unintentionally overlooked; but learning, accidentally, that the value of formaldehyde as a destroyer of the pest was to be tested at the Salt River Works under the supervision of a professional chemist, I sought and was granted permission to be present during the experiments. This was in March last. The results of these experiments were most decisive in determining the inadequacy of the gas; it has a well merited reputation as a germicide, but as an insecticide, formaldehyde has little value. The vermin were not destroyed even when left exposed for two full days in a carriage treated with all the gas contained in 800 c.c. of the water solution of formalin. The gas was forced into the carriage under heavy pressure from an autoclave, and the vermin on which the judgment was based were enclosed in a piece of mosquito netting suspended near the middle of the space. The carriage was, roughly, of 2,500 cubic feet capacity, and all its cracks, crevices and air holes were tightly stopped with cotton wool to prevent escape of the gas. House flies and aphides shut in the carriage were found dead at the expiration of the period, but larval and adult scale insects of several species and plant bugs of three species were found to have survived. Formaldehyde gas of far greater but indefinite strength, generated from formalin tablets, was also inefficacious in destroying imprisoned vermin.

Seeing the hopelessness of formaldehyde, I suggested a trial of hydrocyanic acid gas, the efficiency of which for the purpose I had several times demonstrated to my own satisfaction in dwellings. The outcome was a series of experiments which proved the simplicity, economy and adequacy of this remedy to the entire satisfaction of the officials. Eight particularly bad carriages were thoroughly overhauled after treatment, and not a single surviving bug was found. A few clusters of eggs were discovered, and these I kept undisturbed; although apparently sound at first, each and every egg soon lost its pearly appearance and caved in at the sides, thus leaving little room to doubt that the gas when used at sufficient strength destroys the vitality of this insect's eggs as it does

those of scale insects. No injury befel any of the fittings of the carriages, leather, wood, cloth or metal; this non-liability to damage was established beforehand by laboratory experiments, in which only polished steel was affected and it only by becoming blued when exposed to gas far stronger than would be employed in the carriages.

The "gas treatment" was adopted by the railroad at once after the experiments, and for a year now all the sleeping carriages have been regularly treated. At first the procedure was to disinfect every train as it reached the port terminals from the north, but now a period of about two months is allowed to intervene between the treatments of any one carriage unless there is reason to suspect re-infestation during this interval. Even in these war times, an average of about one hundred and fifty carriages a month are fumigated.

The operations as conducted are simple. The carriages are side-tracked and made ready by pulling out the berths and throwing down the cushions; the water in the filters is drawn off; the shades are raised, all windows closed, and the lampholes and all crevices leading to the outer air stopped with bagging or cotton waste. Two large, round-bottomed china basins are then placed in the corridor, one near the middle of each half. The charges of cyanide are weighed out and the pieces broken to the size of a walnut or smaller. The required measure of water is poured into the basins followed by the measure of acid; then while the mixtures are still steaming hot, the charges of cyanide are successively turned in, and without a moment's delay the operator withdraws, locks the door and plugs the keyhole. At the expiration of the time allowed for the fumigation, the doors at the ends are opened, and after a few minutes the operator passes through and quickly drops all of the windows, refraining from inhaling the gas in the meanwhile. After ventilation has proceeded not less than a half-hour, the generating vessels are removed, and the carriages turned over to the cleaners.

One pound of potassium cyanide (982), 16 fluid ounces of sulphuric acid, and 32 fluid ounces of cold water is the usual charge for each of the two basins. This charge is approximately proportionate to 1 ounce of cyanide to each 90 cubic feet of the space, without allowance for partitions or other contents. Unless the carriages are required at too early an hour to admit of it, the period of exposure is made 4 hours. The gas is used a strength and retained for a length of time far in excess of the requirements for destroying bugs which may be so situated as to get its full effect. The management know this, but deem it indiscreet to attempt an economy that might lead to the escape of vermin located deep in crevices or otherwise protected to an indeterminable extent. The cessation of complaints from the travelling public

has indicated the present charge and exposure to be entirely reliable. Only one complaint was received last year after the adoption of the remedy, and a thorough examination of the carriage concerned revealed no justification for it other than an abundance of lifeless creatures. The eggs discovered were all brought to me, and were found to be without vitality.

The General Manager of Railways made brief mention of the adoption of the remedy and of its excellent results in his last report. The note did not escape the vigilance of the newspapers, and in many, paragraphs soon appeared commenting on the matter and, often under a disagreeable remark in effect "for the good of our readers," explaining how the operations were conducted. The quantities of the chemicals necessary were, however, seriously understated owing to an error in the railway report, and due stress was not laid on the highly poisonous character of cyanide nor on the danger attending the use of the gas. The error and omission should be corrected and it is in large part to effect this by the presentation of the whole truth that I report on the subject in detail. The fumigation of rooms in dwelling houses, the adaptation of the remedy that interests the public and which evoked the newspaper remarks, is fraught with danger of serious consequence when conducted by inexperienced parties, and I cannot recommend any such party to undertake the operations however small the space. It is useless for me to deny, nevertheless, that the gas is often the least expensive, the least troublesome, and the most efficacious remedy for the particular pest to which allusion has been made; and that under the direct, personal supervision of a careful, cautious, skilled operator, who has full authority over the premises for the time, it may be employed without fear of accident.

TICK INVESTIGATIONS.

As was noted in the general statement, studies on stock-infesting ticks have constituted an important part of the whole year's work. Satisfactory progress has been made but more than as much again remained to be done before the subject should be allowed to drop. The chief aim at the beginning was to obtain an insight into the life history and habits of the more important species with the idea of thus securing information that might be utilised in the selection and application of remedial measures. Latterly, the conduct of experiments to demonstrate directly whether or not ticks are responsible for the spread of the disease "heartwater" has been given closer attention. Should it be determined that ticks are associated with the disease, it will probably be expedient to investigate the habits of all the species affecting sheep and goats, the animals subject to the disease, that occur in the east of the colony.

The vital importance of ticks in their known and suspected

relations to stock-farming justifies exacting investigations. In many of the south-eastern districts, cattle suffer extremely from ticks, not so much from the loss of blood, perhaps, as from the abscesses and other forms of sores induced by the attack; and so numerous and injurious have ticks become even in midland and western sections, that numbers of progressive farmers have been impelled to take measures to suppress them. Even from the high Karroo and dry north-western sections, many complaints are received. But it is the probable connection of ticks with the dread heartwater malady that now gives the subject its greatest importance. Heartwater seems to have gained fresh impetus of late years, and is now spreading with leaps and bounds up into the midlands; and there seems grave danger of the infected area in a few years including the best of the angora goat country. With this probability to face, too much study cannot be given to any bearing of the disease, let alone the essential part ticks may have. The farms infected with heartwater to such an extent as to prohibit further small stock farming may be used for cattle farming; but small stock farming is, relatively, so much the more profitable, that the market value of the properties is depreciated by the infection, I am reliably informed, from 30 to 60 per cent.

Observations on ticks were begun in 1898 with a view to closer study in the near future and preliminary studies on several species were recorded in last year's report. At first it was planned to rear the several species whose life histories were desired at Capetown and efforts to this end were made early in 1899. Mr. E. H. F. Mellish kindly placed a couple of calves at our disposal and these were isolated in a small paddock. They were infected a number of times with young of the Bont, Bont Leg, and other species of ticks by the Assistant Entomologist, Mr. Claude Fuller, under my direction; but each time very few attached themselves, and all disappeared within three or four days without any becoming visibly distended. Why these attempts failed, I cannot say definitely; the superior condition in which Mr. Mellish keeps his stock may in part have been responsible, although this did not prevent natural infestation by local species of ticks. The ticks were liberated on various parts of the animals, but chiefly along the belly and about the genitals. Next some guinea pigs were purchased and subjected to the presence of many thousand Bont and Bont Leg ticks; parts of the body were shaved to encourage the parasites to remain but not a single tick became attached.

These perplexing failures, together with the stress laid on the necessity for investigations by the Farmers' Congress, at Kimberley, made me decide to give at least the notorious Bont Tick closer and more personal attention. In late April immense numbers of Bont Tick eggs under observation at the office began to hatch; and immediately arrangements were made with Mr. Llewellyn J.

Roberts, of Cottesbrook, Adelaide, whereby I might take these young ticks to his farm and there rear them on an animal from tick veld, and under the most natural conditions possible. Cottesbrook is a farm where the Bont Tick is giving a great deal of trouble and hence Mr. Roberts was personally interested. To his kind assistance much of the progress made in the studies is directly due.

Two gentle cows were taken from the veld and after being freed of ticks were stabled. One of these was used as a host for the Bont Tick; the other for the Blue Tick. The Bont Tick young were from hatchings at the office; the Blue young were collected on the veld where they were found in vast numbers on grass tops. Only secondary attention was given to the Blue species and whilst the round of life was traced the studies were not altogether satisfying. The Bont species were spared no pains and better results could scarcely have been obtained. It was soon ascertained that while this species passed through but the three active stages of life normal to creatures of its kind, it left the animal between the periods and that the round of life was thus much protracted. The habit of leaving the animal necessitated making provision for catching the creatures as they dropped and of caring for them during the intervals. In its three stages, a tick is known, respectively, as a larva, a nymph, and an adult. Several thousand Bonts were carried through to the nymphic stage at Cottesbrook; and despite keeping them in an incubator heated to eighty degrees during the change from distended larva to hungry nymph, several weeks were thus occupied. It was then necessary for me to return to Cape Town, and I left part of the ticks with Mr. Roberts. These he carried through to the adult stage and sent on to me as I could not get away again. However, I arranged with Dr. D. Hutcheon, the Colonial Veterinary Surgeon, living at Maitland, and with Mr. E. Pillans, the Agricultural Assistant Expert, living at Rosebank, for the gratuitous use of their family cows; and eventually, with this assistance, a number of ticks were carried through the adult stage, thus completing the round of life. The Blue tick remained on its host until replete as adult. The development was rapid, and while at Cottesbrook I was able to study all stages. A preliminary report on the Bont Tick was published in the Agricultural Journal soon after the completion of the life cycle, and I had hoped to publish fully in this annual report on all the species that have been under observation; but owing to my inability to arrange for illustrative figures, the preparation of the comprehensive report is deferred. It seems advisable, however, to record the chief facts ascertained during the year on the more important species, and this will now be done under appropriate sub-headings.

The Bont Tick (*Amblyomma hebræum*).—Nearly all that has been learned thus far on this species is mentioned in the article to

THE BONT TICK AND REDWATER.—About half of the maternal parents of the ticks employed in tracing the life history of the Bont Tick were picked up in the highway near Grahamstown—that is, in a Redwater area. The larval and nymphic stages were reared on a cow supposedly susceptible to Redwater, but this animal did not contract the disease, and remains healthy up to the present time. The adult stage of some of the ticks was passed on Dr. Hutcheon's cow, a stabled animal fed principally on dry forage and not allowed out of a gravelled yard. This cow was observed to be ill on November 1st, and on enquiry of the stable boy it was learned that it had not been wholly well for two or three days. After some days Dr. Hutcheon pronounced the trouble to be Redwater beyond any doubt. The natural inference is that the disease was contracted through the agency of the ticks. All of the male ticks and one female had been applied between three and four weeks before any appearance of illness, and the other females, about 20 in number, nine or ten days before. Besides these ticks, ten nymphs had been applied and had fed to repletion; these were on between October 5th and 12th. The animal recovered under Dr. Hutcheon's treatment but the illness caused a cessation of the milk secretion. Mr. Pillans' cow, which had been infested with a greater number of ticks than Dr. Hutcheon's, did not become diseased; but its immunity may have been due to preventive treatment which was begun when the other cow sickened and continued for several weeks.

THE BONT TICK AND HEARTWATER.—With the approval of Dr. Hutcheon and with the aid of his Capetown assistant, Veterinary-Surgeon Spreull, an effort was made to experimentally ascertain if heartwater was transmitted by ticks. Two angora goats were procured for the work by Veterinary-Surgeon Borthwick and forwarded by him from Somerset East after he had inoculated them with virulent blood supplied by Veterinary-Surgeon Dixon, from Fort Beaufort. The goats arrived in Capetown on October 15th, and at once were put in confinement on the premises of Dr. Hutcheon's office assistant, Mr. F. J. du Plessis. Bont nymphs were liberated on each animal, a number at intervals of three days until four lots had been applied, and as they dropped after repletion they were carefully picked up and placed in the incubator. One animal died October 25th, thirteen days after the inoculation; and the other was killed on the following day when too weak to be able to stand. Dr. Spreull examined both after death and affirmed that they had suffered typical heartwater. The ticks had continued dropping up to the last and not only were fully 200 replete Bont nymphs secured, but also about 75 replete Red nymphs (*Rhipicephalus evertsi* Neumann).

The ticks moulted in due course, and then two young, heartwater-susceptible, angora goats were procured through Dr. Borthwick for

the continuation of the experiment. The animals arrived November 28th, and were taken to my place at Rosebank where I confined them in a small gravelled yard. Efforts to infect them with the now adult ticks were begun at once. To get the Bonts attached was found to be no easy matter and as soon as the difficulty became apparent, the efforts with them were confined to one animal, leaving the second animal for Red Tick infestation. The majority of the Bonts was soon lost; many were actually killed and others escaped. Several methods of applying the ticks were tried. A cloth was suspended beneath the animal and the ticks liberated on its upper surface; a gauze bag was glued over the udder and the ticks placed within it; calico stockings containing ticks, were tied over the feet and legs; the animal was tied in a large wooden box and ticks let loose beside it; again, it was tied to a post and an open box of ticks left near it; again, it was strapped down on its back with its head and legs extended and numbers of the ticks dropped on to it and replaced as they wandered away. But by all of these means together only five males became attached and three of them disappeared before ready for mates. For some reason the ticks evidently lacked appetite. Finally, in order to get a stand of males, advantage was taken of a discovery made in the life cycle studies—namely, that males pulled from an animal bite again with alacrity. In compliance with my requests, Mr. O. H. Glanville, of Addo, Mr. L. J. Roberts, of Adelaide, and Veterinary-Surgeon Dixon, of Fort Beaufort, all sent me numbers of males pulled from cattle. Males pulled off generally die within three days and hence only a small proportion of those sent me were alive on receipt; but of the survivors of the different lots, seventeen took hold of the goat and remained. These were given mates —seven females attaching December 6th, and fifteen others by December 12th. As was expected several contented themselves by settling down by males already mated. All of the females developed slowly, possibly owing to a lack of vigour in the males arising from the transference, but none sought to leave. Two replete specimens fell December 17th and five others between December 21st and 25th. The animal had been restrained from biting the infected parts up to the latter date, but in mercy it was then given more liberty of movement than it had been previously allowed, and in consequence several partially swollen females were lost. Since their application the ticks had been a continual source of severe irritation to the animal; one of the teats had become hard and swollen, an abscess appeared to be gathering, and small festers had formed. These bad effects may have had their origin from the unclean condition of the mouth organs of the males employed. Fragments of flesh naturally tore away with the toothed mandibles and barbed hypostomes when the ticks were forcibly taken from the cattle and doubtless became putrid

during the three or four days which elapsed before the transference to the goat was complete. One of the same foul-mouthed males bit me on the arm and for nearly a week the limb was painfully swollen whilst the wound even now, over three months later, gives frequent annoyance by itching. The sores on the goats increased in number after the animal was permitted to lick and bite the ticks.

On the evening of Sunday, December 31st, the goat was observed to be in high fever. For several days before it had ate and drank irregularly although on the previous day it had appeared all right other than having a somewhat higher temperature than usual. The temperature remained constantly above 106·6° with a maximum of 107° for two full days and then began to fall, at first slowly and then very quickly until at the end of a second forty-eight hours it again stood at normal. During the period of high fever the animal refused food and drink and lay with its head down. It was always able to keep its feet when compelled to stand, and stood much of its own accord. As soon as its temperature began to fall, its appetite returned and by the end of the week it was feeding, drinking, and behaving in general as if nothing had happened.

I believe that the animal suffered a mild attack of heartwater and that the disease was induced by the ticks with which I had infected it. The evidence, however, is not conclusive, and hence the experiment was not entirely satisfactory and can only be taken as strongly indicative that the ticks communicated the disease. The organism directly responsible for heartwater is unknown. The diagnosis depends chiefly upon the post-mortem appearance of the viscera, and as the distinctive features are evident but feebly, if at all, until an animal is very near death, it would have been practically useless to have killed and examined the goat, suffering as it was from only a mild attack. There is, however, a somewhat characteristic temperature curve to the fever of heartwater, and this curve was followed in the case of the goat. A second experiment, one having the same object but conducted on a larger scale, is in progress at the time of writing, and in the annual report for the present year I hope to record conclusively whether or not there is any association between the Bont Tick and the disease.

The second goat was infected with the adult Red Ticks. These ticks had dropped from the two diseased animals between the 19th and the 26th of October, but chiefly before the 23rd, the date on which the first of the goats had shown fever; hence few of the ticks had imbibed blood at the most virulent stage. Far less difficulty was experienced with this species than with the Bont. Both males and females located themselves about the anus where they appeared to cause little irritation, and where, if they did, they were quite safe from the animal's efforts to get rid of them.

Twenty males and thirteen females attached themselves and remained; the stay of nearly all dated from November 29th. The females became replete and dropped off one by one after a week. Gradually the males grew fewer in number but six were on at the expiration of a month. The body temperature was taken at least once a day until the 4th of January; and three weeks later, no indication or appearance of fever having been observed, disposal was made of the animal. I am not so much disposed to infer that the negative results with this goat shows that the Red Tick does not convey heartwater as I am disposed to infer from the results with the first goat that the Bont Tick dose convey it; there is the possibility that the ticks lacked sufficient virulence to consider. The result is indicative, however, and may prove of value in connection with the results to be obtained from a duplicate experiment now being conducted.

Should either of the two species discussed, one or both, be found agents in the transmission of heartwater, a wide field for investigation will be opened. It will first be expedient to ascertain if any other species are likewise concerned. The suppression of such species as are found implicated will then, it is highly probable, be looked upon as the most promising means of preventing the disease. And in order to most systematically and intelligently contend against the ticks it will be necessary to know the habits and life history of these—that the measures adopted may be in accord. The range of hosts of the different species will be a detail of importance. And there will be a score of questions for settlement, such for instance, as, "Are not most of the Bont Ticks found on small stock from mothers which passed their final feeding stage on cattle?", the solution of which will influence the choice and conduct of suppressive measures. Then, too, it should be ascertained if ticks from animals "salted" to heartwater are capable of transmitting the malady.

The Bont Leg Tick (*Hyalomma ægyptium*, Audouin.)—This species of tick has been received or collected from nearly all sections of the Colony and is particularly pestiferous in the Midlands and the north-western sections. It is found about Capetown, but not in numbers. While its life stages have not been consecutively studied, observations of value have been made on them. In the adult stage, the species is nearly equal to the Bont in size, many specimens of repleted females measuring no less than three-quarters of an inch in length. And like the Bont, this species possesses a long rostrum, and frequents the under and comparatively hairless parts of the animal. All farm stock seem subject to attack but sheep and goats suffer most severely. The life period is probably far shorter than in the case of the Bont as all the stages observed have been of shorter duration. Under ordinary conditions, however, it is unlikely that more than one generation

occurs in the course of a year. Eggs laid September 18th and onward began to hatch December 6th; others laid October 19th and onward began hatching November 25th; others laid December 11th began February 6th; and a fourth lot, from females which started to lay January 5th, or two weeks after being removed from goats, began to hatch February 15th. Thus the period from the disposing of the females to the appearance of the young may in summer be as short as eight weeks; the shortest corresponding period observed in the case of the Bont Tick was nearly fourteen weeks. The longest corresponding period in the case of the Bont Leg was six months, and in the case of the Bont, eight months. Unfed larvæ of the Bont Leg Tick have been kept in a tightly stoppered tube without moisture from mid-January to early August or full six and one-half months. The larvæ and nymphs leave the animal to moult. Small lots of larvæ have been reared on a goat and the dropping observed to occur in three and one-half to four and one-half days. From certain actions, it is inferred that the females seek the males but I have no definite knowledge on this point.

If heartwater is transmitted by the Bont Tick, it is probable that it may likewise be transmitted by the Bont Leg Tick; and if this possibility be a fact, the disease is likely to spread through the Zwart Ruggens and into the higher Karroo more quickly than it has spread in the more coast-wise districts. The Bont Leg Tick occurs down to the coast, but, apparently, does not thrive there; and the disease, if it depends on ticks of the Bont and Bont Leg type to transmit it, has thus far been depended principally on the Bont, which has itself had to become established and spread into new territory to spread the disease. The disease is now getting into sections where the Bont Leg specie is abundant, and hence, if it can be transmitted by this already established species, it has now one less hindrance to its spread than before.

No data have been obtained which tend to explain the relative abundance of the Bont Leg Tick in the Karroo compared with the more moist coastal districts. On the other hand we have indications that the species is well fitted for a dry climate. Batches of its eggs kept at the office in dry card-board boxes have hatched while batches of eggs from the Bont Tick and from the Blue Tick kept similarly have uniformily lost vitality. The long drought of 1897-1899 in the Midland districts did not appear to affect its numbers. Mr. R. F. Hurndall, of Aberdeen Road, informed me that there was fully as many on his goats during the rainless spring of 1897-1898 as during the previous good seasons.

The common name assigned to the species is suggested by the "bont" or variegated features of the legs of the adults; the outer part of each joint of the otherwise brown legs is whiteish. The male above is almost black with a pale marginal stripe. The replete female is brown with irregular light blue stripes.

The Red Tick (*Rhipicephalus evertsi*, Neumann).—The Red Tick is another species widely distributed in the Colony, and whenever I have seen any ticks at all on an animal, I have almost invariably seen at least a few of this kind. Severe infestation is, however, exceptional. The adults are remarkable for their decided preference for the hairless parts of the skin adjacent to the anus. Fifty or more may be clustered thereabouts when none are to be found elsewhere. The larvæ and nymphs likewise are partial to a particular part, congregating in the ears; few are to be found in other situations, and almost all the ticks that I have taken from the inner surface of the ears of animals have been of this one kind. The nymphs somewhat resemble distended females of the Blue species, but are very much smaller; they measure about three-sixteenths of an inch in length. The adult male is a dark reddish-brown, almost black, above with a narrow paler margin. The female is of the same shade on the front of the back (the shield) but more distinctly reddish-brown behind. Both sexes are much longer than wide, more so than most ticks. Before distension, both measure from one-eighth to three-sixteenths of an inch in length; after distension the female measures up to two-thirds of an inch. The legs are much paler in colour than the back, being dark-amber in colour, and by this characteristic the species may be easily distinguished from a near ally, the Larger Blue (*Rhipicephalus bursa?*). The latter tick much resembles the red in shape, size and colour but has dark-red legs. A remarkable feature in the life cycle of the Red Tick is that the first moult, that from larva to nymph, is passed *on* the host whilst the second moult, that from nymph to adult, is passed *off* the host. After the moulting on the ground, the adults climb grass or bush and await the passing of animals as do the larvæ. These waiting Red Ticks are a familiar sight to most of our farmers. The Larger Blue waits similarly while Bonts and Bont Legs generally lay half hidden on the ground. Eggs of the Red Ticks have several times been successfully incubated at the office in glass-topped pasteboard boxes without moisture or shelter from light. The nymphs have been found to moult without moisture; and this indifference to a dry atmosphere probably accounts for there being almost as many of this species of tick on open pastures as in bush covered country. A systematic study of the habits of the tick in all its stages is now in progress.

The Blue Tick (*Rhipicephalus decoloratus*, Koch).—This is the most abundant and the most widely distributed tick in the Colony. It takes its popular name from the colour of the distended female, which is a displeasing bluish-gray. The small size of this species, its almost colourless, slender legs, the colour of the female, and a small but distinct tail-like projection from the body of the male, are characters which serve for its ready separation from our other

common ticks. The distended female measures about one-half inch in length by about one-third as wide. The male is brownish-yellow with dark markings, is only about an eighth of an inch in length, and in common with the early stages of both sexes escapes general notice; it is generally to be found beneath the distended female.

The Blue Tick is nearly related to the common cattle ticks found in Australia, North and South America and in other parts of the world. Professor G. Neumann, an eminent authority on ticks, considers that it should be connected with the American cattle tick (*Rhipicephalus annulatus*, Say—*Boophilus bovis*, Riley) as a variety and he will probably classify it as such in a new work which he has in preparation.

Notes on the life cycle of the species were given in the *Agricultural Journal* for November 24th, 1898, by Veterinary Surgeons Dixon and Spreull. I have reared several different lots on cattle and goats but have not yet traced all the habits. The eggs to the number of several thousands are laid on or near the surface in grass stubble or similar shelter and the larvæ on hatching ascend the grass or bush as in the other species studied. Two thousand two hundred and fifty larvæ have been counted at the top of a single blade of grass. By day and by night, through wind, rain and light frost, they remain at their posts. Grass found infested, and protected by a barrier of cut thorns, was found to be still infested three months later, which shows that the young ticks may live at least this length of time on the veld. The female, after dropping from the host, starts laying in from five days to two weeks in summer, while in winter at Cape Town, at a temperature of 65°-70° she delays until the third or fourth week has passed. Similarly the incubation period of the egg varies from three weeks to three months. At a temperature of 85°-90° in the incubator hatched eggs have been obtained in four weeks from the dropping of the mother tick, which shows how heat hastens the development. Some moisture appears necessary during the incubation period, as several batches of eggs kept in dry boxes have shrivelled and failed to hatch.

The Blue Tick moults twice but remains on its host through both changes, thus differing materially in habit from the Bont, Bont Leg, Red, and other South African species; it however becomes motionless and appears as if devoid of life before both moults. The larva begins to distend by the end of the second day of its attachment, and seems to cease enlarging in from three to three and one-half days. Two days later, under a magnifying glass, the body contents may be seen to have shrunk away from the skin back to the mouth organs. Finally this larval skin ruptures across the top, in front, and the tick, now in the second or nymph stage, crawls out. This change has been observed to

take place as early as six days from the attachment of the larva, and as late as the tenth. The nymph settles down near by, and after a few days distends just as did the larva. In appearance, it resembles the adult female but its sides in place of being parallel converge slightly towards the rear. After the fifth day from the moult, no further enlargement is perceptible and doubtless feeding has ceased. In another day or two, the outlines of the adult are dimly distinguishable through the translucent skin, particularly across the front, and shortly thereafter there is a rupture as before, and the tick makes its appearance as the adult. The nymphic stage has about the same duration as the larval; in instances observed it has varied from seven to ten days. The two stages together in numerous cases occupied from fifteen to twenty days. The male is very similar to the female in size, colour and general appearance just after the moult, and, being small, one might be easily mistaken for the other when viewed by the unaided eye. The female settles down almost at once and so, apparently, does the male; but the latter wanders much farther and is therefore not easily traced. After a day or two males are seen crawling about in the hair, evidently searching for mates. I am not certain how soon mating takes place after moulting, but my observations lead me to conjecture that both sexes feed for a short time, and that the male then lets go his hold and looks for a companion. However that may be the females nearly all have mates by the fourth day. Distension has begun by that time and seems to proceed whether or not a male has come up; this is another point that needs confirmative observation. A few females observed have fallen in seven days but the great majority have not fallen until after the ninth day and some have remained until the eleventh. The male remains on the skin when his mate drops but what becomes of him afterwards I have not observed.

The life period on the host for the female is thus from three to four and one-half weeks. No individual ticks that I have observed have, however, dropped in less than twenty-three days and most remained for twenty-six. The entire life cycle may be passed in two summer months, but in fact probably seldom takes less than two and a half or three. There is a possibility of three broods a year in our Cape climate and a probability of at least two broods.

The life period on the animal during the winter months is not likely to be more than a day or two longer than in the summer, at least when dry weather is the rule in winter as it is in our eastern sections. Being hidden in the hair when young and pressed against the warm body of the animal, the tick is kept warm throughout its stay. Numerous nymphs and some larvæ which I scraped off after they had ceased to feed moulted when kept in glass tubes; but the change in some cases took over a week

in place of the two or three days as it would have on the warm skin. Some of the adults obtained in this way were kept alive for twelve days in the tubes and were then placed in spirit; as they can thus do without food, it cannot be necessary for them to settle down at once after moulting on an animal.

Other Ticks from Farm Animals.—There are several other species of ticks found on farm animals in South Africa but as far as I know none of them are of such importance as those discussed above. Specimens of some have been sent to Professor Neumann and the determinations of the identity of those now to be mentioned are by him. *Rhipicephalus capensis*, Koch, has been collected from cattle at Stellenbosch; it is much like the Red Tick. *Rhipicephalus bursa* (?) has been collected from several localities in eastern, western and southern sections of the Colony. The distended female resembles the distended female of the Red Tick in most respects but has much darker legs. The male looks much like the male of the Bont Leg Tick but lacks the "bont leg" characteristic; it also differs in having a small but distinct blunt, tail-like projection. The eyes of both sexes are yellow. *Ixodes pilosus*, Koch, has been found common in early summer at Stellenbosch and is said to occur at Grahamstown. The distended female is about the size of the Blue but is more robust; in colour it is far darker, being blue-black with a ruddy tinge. As its name indicates, it is somewhat pilose. The male is chestnut-brown in colour, is very small, and has the remarkable habit of burying its rostrum in the sexual orifice of the female. It is frequently thus attached to its mate when the latter is pulled from the host, and if torn away it seeks to re-establish itself. Similar proceedings have been observed by E. J. Wheler, Alnwick, England, in the case of *Ixodes reduvius*, a closely allied species. *I. pilosus* has been taken from cattle, a horse, a mule, and a young pig. Large numbers of larvæ have been reared on goats and found to drop after becoming distended.

A bont-legged, bont-backed, large and very active tick common on the land tortoise (schild pad) has been determined by Neumann as *Amblyomma devium*, Koch. Two large nymph ticks taken from a goat from Somerset East proved on moulting to be, respectively, male and female of this species. Dr. Davidson, of Adelaide, sent me a number of adults taken from tortoises; Mr. A. W. Douglass, of Heatherton Towers, some taken from a puff adder; and Mr. L. J. Roberts, of Adelaide, a specimen from a black snake. The common Bont Tick is said by many people to infect snakes and tortoises, but it seems likely that the Bont Tick is confused with the present species; still, since this species can feed on a warm blooded animal, it is not unreasonable to suspect the true Bont of sometimes feeding on a snake or tortoise.

The Tampan (*Onithodoros savignyi*, Audouin) deserves mention among the stock-infesting ticks. It is a broadly oval, leathery-skinned, dirt-coloured creature, and at most measures five-eighths of an inch in length. In its habits it more resembles a bed-bug than any of the ticks above mentioned, it remaining on its host at the most for two hours at a time. Specimens have been fed on a fowl, a dog and a goat. On good authority I learn that it attacks horses and cattle and probably no host is preferred to man. It is widely distributed in the north-west of this Colony, in Rhodesia, Bechuanaland, German South-west Africa and Portuguese East Africa. Specimens have been received from Zeerust in the Transvaal and it is said to be not uncommon in parts of Oudtshoorn in the south of this Colony. It frequents the shade of vegetation under which animals are wont to shelter themselves, and said to sometimes take up an abode in native huts. It is a wonderfully active but most repulsive creature.

The Fowl Tick, sometimes also called Tampan and Wandluis, may as well be mentioned here as elsewhere. Professor Neumann has examined specimens and considers the species to be *Argas persicus*. A study of the life history is now being made. The tick has been found to remain attached to its host, commonly the fowl, during its larval stage for about five days; it then leaves and moults in concealment. In its subsequent stages it visits its host by night and remains for about an hour only, during which time it distends itself fully with blood. As a nymph it moults twice, not once as do the cattle ticks which have been studied, and one successful visit to the host suffices for each of the two stages. The tick becomes larger with each moult but retains the same general appearance. At the third moult both sexes, which may then for the first time be distinguished, are about one-fourth of an inch in length, ovate, and brown stippled with dark spots. The females swell to about five-twelfths of an inch in length and one-fourth across the broadest part on partaking of food, while the males increase but a trifle. On the part of the female, visits to a host are alternated with the deposition of eggs in the crevice or shelter selected for concealment. A variable number of eggs are laid at a time;—the complements counted have ranged from 50 to 120. A number of females that have already alternated engorgement and oviposition three times have fed a fourth and are, at the time of writing about to oviposit again. About four weeks necessarily intervenes between the visits to the host; and the interval may be extended to upwards of a year. Three females confined in a box at the office are known not to have fed for a year and with very little doubt they are part of a lot collected in a fowl run twenty-one months ago.

Frequent instances of fowls and ducks, particularly young ones, dying from the effects of Fowl Tick attack are reported. The

fatalities are probably, as a rule, due to sheer loss of blood and they generally follow a sudden decrease in the number of birds confined in a house or the enclosure of birds in a house which has stood vacant for several weeks. The pest occurs all over the Colony and in many foreign countries having a warm climate. I have seen it in cotes of pigeons but have not chanced to see it actually on the body of any one of these birds. As I know it to occasionally attack a man, it not unlikely has a wide range of hosts. It is this tick, I believe, that according to ancient writers infested the huts of natives in parts of Persia and which through its bite often brought illness and death to strangers who slept therein. This old story, fanciful as it seems, may be based on fact. The districts of Persia concerned are said to be fever-country and it is not improbable that the tick can, and does, transmit fever germs from inured or diseased natives to susceptible strangers. Similarly it may be a transmitter of diseases among fowls.

MISCELLANEOUS INSECT NOTES.

Codling Moth.—This apple and pear fruit pest is steadily strengthening its hold in the Western Province fruit districts, and we may expect to hear much of it within four or five years for although now in comparatively few orchards it is scattered over a considerable area, and is bound to increase. Our best fruit growers are on their guard, and are ready to vigorously contend against it, but it is safe to predict that, unless compelled to do so, the majority of the farmers will not raise a hand to check its multiplication in their orchards. Thus far, practically all the damage has been to fruit shortly after setting time; but in one Constantia garden fully three-quarters of the pears on an isolated row of trees were infested in late summer. It is worth recording that a number of reliable people believe they knew this pest in the Cape Peninsula many years ago. Sir Henry de Villiers, the Chief Justice, states that in his boyhood apples in a certain garden at Wynberg were tunnelled by a caterpillar which if not the larva of the Codling Moth, worked precisely like it; but for many, many years, until very recently, he did not see the work of the insect or have the matter recalled to mind. The Codling Moth, to my knowledge, now occurs in Graaff-Reinet and vicinity, including New Bethesda; Capetown, Claremont and Constantia in the Cape district; Somerset West Village, Stellenbosch Village, and against the Simonsberg, in Stellenbosch district; Wellington Village, in the Paarl district. It is suspected on one farm near Simondium on the Paarl side of the Simonsberg, and it is highly probable that it occurs on scores of farms where its presence has not yet been recognised. The report that it occurs in Natal appears unfounded, the Natal Entomologist not being able to locate a single occurrence in that Colony.

THE FRUIT FLY (*Ceratitis capitata* Wied).—Less damage than usual but more than last year was done by the Fruit Fly this season, 1899-1900, in the western part of the Colony; in the middle and eastern sections the damage seems to have been severe. The reason for the greater abundance of the pest one year than another has not been discovered. Hundreds of maggoty fruits of various kinds have been collected from scores of localities and the flies reared, but not a single parasite has been obtained; hence the fluctuation cannot be due to parasitic enemies of the species. Probably differences in the rainfall and temperature between one season and another are largely responsible. Some observant people have told me that years of observation has taught them that early frost prevents an abundance of the pests for the following season; other people believe that late frost exerts the same influence. Both may be right in their opinions, but the variations extend to localities where no frost occurs, and hence frost cannot be the sole cause. Similarly, neither copious nor scanty rainfall, summer or winter, can be the cause. Last year I reasoned to myself that warm spells during the winter followed by cold or excessive precipitation was probably the explanation. A study of the temperature and rainfall for the winter months in seasons marked by exceptional abundance and exceptional absence of the pest has, however, failed to substantiate this view.

Direct proof that the flies live through the winter and oviposit in the spring fruit has not been obtained, but I believe this to be the case. There is some breeding in winter fruits but not in all localities as in many places the peaches become "blown" where no winter fruits are grown. The flies, which come from maggots fed in late fruits appear with no developed eggs in the ovaries. The late fruits, cultivated and ornamental, almost invariably furnish a great number of these flies; and it is my idea that this number decreases as the winter progresses so that by the time the early plums and apricots are ripening, very few flies are left to propagate. Flies from peach-fed maggots emerge up to about April 1st: from pear, apple and quince-fed maggots to fully six weeks later. About a peck of affected peaches was collected on March 8th of last year. The lot was divided, and part placed in a cage kept at the office, while the remainder were caged out of doors. The flies emerged in both cases at the same time, beginning with March 30th. These flies, about sixty in number, were confined under fine wire netting out of doors, and kept as nearly as possible under natural conditions. Eggs were found developed in the ovaries of some four weeks later and after a few days more had elapsed three pairs were noticed in coitu. An apple was then hung against the netting and several flies apparently deposited eggs in it; no maggots, however, developed.

The flies had begun to grow less numerous from the first, and with each rain some were found destroyed, generally in the corners

or crevices of the sides or bottom of the enclosure. During cold days all would remain hidden amongst the leaves and rubbish but when the sun shone warm they would fly about or sun themselves on the wire. The leaves gradually became matted down and afforded less and less protection. A storm in late June left few survivors and a severe hail-storm on July 8th killed all of these but one much battered female. This poor creature, favoured by fine weather, lived on for eleven days longer. Its length of life as an adult was thus about sixteen weeks.

One new food plant only was recorded last year, but this is an important one, the prickly pear. Quantities of this fruit were found infected in Capetown in April and May and as fruit on the plants this year is in the same condition the attack cannot have been exceptional. I have, moreover, seen maggots which were probably fruit fly maggots in prickly pears at Cookhouse and near Grahamstown; and I have read recently that the prickly pear is one of the food plants of this species in the south of Europe. Thus far, only overripe prickly pears have been found infested.

The Department, at the suggestion of the Board of Horticulture, again nvited applications for netting to protect choice fruit from the Fruit Fly, but there was a poor response, only 4,000 yards, two yards wide, being ordered. No merchant in the Colony has yet shown push enough to stock and sell the netting; but one or more Natal merchants have done so, and are supplying at very reasonable rates. The Natal fruit growers appear to think more of this protective measure than we in Cape Colony.

The Department also acted as free agent for old fish netting to be used in protecting fruit from birds; 35,000 square yards were imported and distributed. The mesh of the ordinary fish netting is large enough to permit the entrance of the little "glass-eye" birds (*Zosterops* sps.), wit-oogjes, and to meet their case, a limited quantity of a smaller mesh special netting has been imported. The latter netting has the additional advantage of being new and very light, and as its cost is equivalent to only a penny a square yard, it should find a sale, especially for the protection of loquats and figs.

Pear Slug (*Eriocampoides limacina*, Retz)—An extension of the range of this pest calls for remark. Traces of infestation were discovered in the Drostdy garden at Worcester in May last, and an examination of the premises in January of this year confirmed the suspicions. Numerous trees were found slightly infested on a Rawsonville, Goudini, farm during a visit there in January. It seems as if the pest must be blown along by the wind as it progresses steadily and not by long leaps as it would if it travelled with nursery stock. The Worcester occurrence probably originated from saw-flies bred in the direction of Rawsonville. A few medlar trees almost depoliated by the Pear Slug were observed this season. I have not previously recorded this tree as a food plant.

Part of the failure to suppress this easily controlled pest may in some instances be attributed to the use of the wrong kind of hellebore as an insecticide. White Hellebore *(Veratrum album)*, not Hellebore or Black Hellebore (*Helleborus niger*) should be employed. In general it is better to use an arsenical poison, however, as hellebore on the foliage loses its virtue quickly, whilst arsenicals are actively poisonous as long as they remain. At my recommendation George Findlay & Co., Capetown, have imported a new arsenical spraying compound—arsenite of copper. This substance is now recommended to farmers by the United States Government in place of Paris Green ; it keeps in suspension better, is less liable to injure foliage, and (in the United States) is cheaper.

Scale Insects.—The Red Scale is the burden of more letters of enquiry received at the office than any other insect. Still it is improbable that it does any more damage than in the past. During the last few years, I have met with several elderly gentlemen who are positive that the scale was present in the Western Province and destructive to orange and lemon trees in their boyhood—45 to 50 years ago. The increased attention to the insect now is largely due to the fruits of these trees commanding far higher prices than formerly.

The occurrence of a fungus (*Sphærostilbe coccophila*) in Florida parasitic on scale insects of the Red Scale type was mentioned in last year's report. An attempt was made to secure material of this fungus; some was sent me on request by the Florida State Entomologist, P. H. Rolfs, but the package failed to reach here. Recently, Claude Fuller, the Natal Entomologist, wrote me that he had found this fungus exceedingly prevalent in Natal, and he has promised large sendings during the coming winter. Owing to our long, dry summer it is unlikely that the fungus will prove of great value to us, but there is a chance that it may thrive during our moist winters and thus minimise the amount of scale which survives the cool season and breeds in the spring. Much of the scale succumbs during the winter under our present conditions.

No more *Orthesia insignis* has been found at the florists in Rosebank where it was discovered in quantity two years ago. The scale, however, still exists about Capetown, as three parties brought in specimens during the year.

The Thorn Tree Scale, (*Lecaniodiaspis mimosæ* = *Prospophora prosopodis*, var. *mimosæ* Maskell), the scale which has cleared portions of Bedford and Fort Beaufort of thorn trees on more than one occasion has been received from Windhoek, German South-West Africa, through the kindness of J. C. Watermeyer, formerly of this Department. The scale there destroys the Cameel Doorn (*Acacia giraffæ*). It might prove very profitable to introduce a quantity of the insect from Windhoek at the season of the year

when eggs are beneath the scales, and to distribute this in eastern sections of the Colony where *Acacia horrida* is over-numerous.

The Harpuis Bosch Scale (*Asterolecanium, n. sp.*) was the subject of an illustrated article by Claude Fuller in the *Agricultural Journal* for January 19th. This is another scale that attacks and destroys a native plant, in this case a worthless and veld-usurping bush (*Euryops tenuissimus*). The scales are almost hidden beneath a mass of tangled, glassy threads of a brittle substance secreted by the insect. The scales within this mass may be easily exposed by brushing, and are then seen to appear like globular glass beads. They are smooth, translucent, and shiny, and more or less yellowish; in diameter they measure about one-fourteenth of an inch. Weatherworn scales may be almost bare. Through the kindness of Mr. W. Frost, Thibet Park, Tarkastad, who for many months sent us infested twigs about once in two weeks, we were able to follow the development of the insect through a generation. There is but one brood a year. Eggs are deposited shortly after the first of the year, and are to be found beneath some of the scales until after the middle of March, by which date, however, the majority have hatched. The eggs under four scales were counted, and were found to number from 145 to 269. They are very small, and pinkish-brown in colour. The insects develop slowly, scarcely growing at all through the winter. The winged males had emerged from specimens received October 24th, but no traces of eggs were found in females received a month later.

The bushes die when much infested by this scale, but, curiously, withstand a far greater degree of infestation by another species of scale to which the plant is subject. The dissemination of the scale with a view to suppressing the food plant has been suggested. As it is an insect which has only been found on the Harpuis bosch, it is quite safe to spread it. To infect fresh areas, twigs well covered with scales sheltering eggs should be cut and tied in close contact to twigs of the uninfested bushes. The best time for this work is the latter part of January. Mr. Frost is trying to more thoroughly infest the plant on his farm by scattering scale-covered branches from dying bushes amongst the healthy bushes. As might be expected, the insect is preyed upon by parasites, and it is not unlikely that for years at a time these may prevent an increase in its abundance. The bush is pestiferous in the Sneeuwbergen, near Graaff-Reinet, and in the Winterbergen, near Tarkastad. Near Lesseyton, on the Eastern System, it may be seen along the railroad track. The scale is found with the bush in both the Sneeuwbergen and the Winterbergen.

Fowl Midge (*Simulium sp.*).—The Fowl Midge illustrates how a comparatively common and injurious insect may long escape notice. There is much reason to believe that it has pested fowls in the Cape district and elsewhere for many years, and yet up to

about eighteen months ago no attention seems to have been drawn to it. Mr. B. McMillan, of this Department, who—to use his own expression—is a bit of a naturalist, observed it amongst his own fowls at Wynberg in October, 1898; and subsequently with some aid from Mr. McMillan, the Assistant Entomologist, investigated its habits. The injury is all done by the female flies. These get on to the fowl when they are roosting at night, and, crawling in through the feathers to the skin, they suck the blood as would mosquitos. Each fly draws only a small drop, but the aggregate loss of blood may be sufficient to seriously injure the birds, and even to kill them. The male fly was not found by Mr. Fuller. It may not have been about at the time and no search has since been made for it. The female is less than half the size of the house fly, is stout bodied and dark coloured, and provided with two short, broad, almost veinless wings; the head is small and nearly "all eyes," while the thorax is disproportionately large. The wings when at rest are uplifted. Mr. McMillan tells me they sometimes come from the fowls in "clouds" at night when the feathers are disturbed, and dash against the flame of a candle in such numbers as to extinguish it. The pest is most numerous in the spring and early summer.

The mother fly seeks a running stream when about to lay her eggs, and crawling down the face of a stone or other object she deliberately enters the water, enveloped, however, in a bubble of air. She remains immersed for several minutes busily engaged in ovipositing. Mr. Fuller watched one enter the water and three minutes later he raised the stone and counted the eggs already laid: there were 160. The full complement of eggs is a much greater number; one fly was opened, and found to contain 580. The eggs are white at first, but later become yellowish; they are ovate in outline, about one hundred and twenty-fifth of an inch in length, and are laid on end in clusters of several hundred. The incubation period was ten to twelve days in case of a cluster under observation. The larva grows to be about one-third of an inch in length and from being almost transparent gradually becomes translucent brown or grey. It lives in running water, and collects food by a pair of huge, scoop-like organs situated on the head. It generally maintains its position by clinging to some surface with hooklets which project from behind, but is also able to spin a thread of silk from some support, and to float from the end of this. The pupa stage is passed in a shoe-shape cocoon of silk attached to some object in the water. The cocoon is brown in colour, about one-quarter inch in length and open at the end. Through the open end project the thorax, head and long, waving, respiratory filaments.

APPENDIX A.—Tick Destruction Experiments.

Notes on various substances tested at Cottesbrook.

Dr. D. Hutcheon,
Colonial Veterinary Surgeon.

I submit the accompanying notes on experiments with various substances as tick destroyers, conducted by L. J. Roberts and myself at the latter's farm, Cottesbrook, in the Fort Beaufort District, this past June and July. As you are aware, I had expected to do a little experimenting with insecticides in co-operation with Veterinary Surgeon Dixon, but the plan proved impracticable owing to the distance separating our headquarters.

Where I say any of the substances killed the ticks, I mean that it killed male and female Bont Ticks as well as other kinds.

CHAS. P. LOUNSBURY, Entomologist.

Cooper's Dip.—This substance had commended itself to Mr. Roberts prior to my visit, and as he was contemplating its use again on part of his herd, I suggested that we employ it in definite proportions and afterwards examine the cattle to note the effects. In all about seventy cattle were sprayed, May 29th to 31st. The dip was weighed out into six ounce packages and each package worked to paste with water as wanted and then diluted to three gallons. For some of the cattle the dip was used with hot water, for others with cold water, and to vary the experiment a pound of home-made soft soap was used with each three gallons applied to a third portion. The application was made in a forceful spray from a "Success" pump, and the poison was kept well agitated by three return jets of the liquid from holes drilled through the cylinder of the pump, supplemented by hand stirring. Fair, warm weather (for winter) prevailed at the time and for some days afterward. Mr. Roberts, from observing the results of previous sprayings, said about four days would elapse before the greatest mortality appeared among the ticks. However, we examined a few cattle daily for over a week without being able to detect any marked decrease in the numbers of the ticks or finding more than a small percentage, perhaps three to five dead from the effects of the dip. In death through Cooper's Dip or the arsenical preparation used later, the body of the tick is firm and swollen; hence victims are easily detected.

Just previous to the general spraying Mr. Roberts and I personally attended to the treatment of a cow desired for my tick studies. For this cow the wash consisted of six ounces of dip in three gallons of cold water. The skin was made thoroughly wet, and to ensure penetration to the skin I rubbed the wetted hair hard with my hands. The effect on the ticks was practically *nil*. We thought at the time that the dip must have contained less arsenic than usual, but a Government analysis since made of a sample taken from one of the packages opened shows the proportions of the ingredients to be:—

Moisture ..	.. 7·83	Free sulphur	.. 60·12
Arsenious sulphide	.. 4·65	Sodic sulphide	.. 4·81
Arsenious oxide	.. 17·78		

As this analysis compares very favourably with analyses previously made of Cooper's Dip, it appears that the dip we used was probably up to the standard. The dip was found to have several disadvantages as a spraying mixture. It settles quickly and therefore needs much agitation; and a disagreeable scum forms on the surface.

Smith's Scrub Exterminator.—The trials with this was prompted by the insecticidal properties of arsenic in solution. A 12 lb. tin was procured from the magistrate and the applications made in water solution. The stuff dissolves readily and proved easy to work with though without good wetting capacity. Fearing to damage the cattle it was used only on the udder and rear in most of the proportions. The following strengths were used: one pound of the poison to 4, 6, 8, 10, 12, 14, 16,

18, 20, 22 and 24 gallons of water, respectively. The applications were made in clear warm weather, June 19th, 20th, 21st and 29th. No rain but much wind followed. For all but the three strongest solutions, two or more cattle were used. The proportion 1 lb. to 4 gallons caused considerable inflammation and swelling on the rear of one cow bad with scab, and the beast appeared seedy for a few days: eventually she pulled around all right and the scab as well as the ticks were quite eradicated. Proportions 1 to 6 to 1 to 12 killed all the ticks, and that without causing apparent injury to the cattle. 1 to 12 killed almost every tick. From 1-14 to 1-24, the effects were decreasingly effective but even the weakest solution killed many, while 1 to 14 and 1 to 16 killed over one-half. The effects were apparent twenty-four hours after the sprayings but some deaths occurred after forty-eight hours. As with Cooper's Dip, the victims were swollen and firm.

No recent analysis of Smith's Scrub Exterminator has been made at the department. One made several years ago showed the ingredients to be three parts of white arsenic and one part caustic soda: to be exact, the arsenic was given as 76·23 per cent and in the form of $As_2 O_3$. When mixed with water the two ingredients combine to form arsenite of soda. The department pays £34 per long ton for the commodity packed in tins of 11 to 12 lbs. in London. This is equivalent to about 3½d. per pound. Ready made arsenite of soda costs less than this proprietary article and is essentially the same thing The department has paid from £24 to £32 per ton for the crude arsenite. Perhaps arsenate of soda would answer as well as the arsenite for the purpose as I know it to be an intensely active insecticide. An excellent grade of this chemical may be bought in England for £19 per ton, equivalent to 2d. per pound in bulk.

The cheapness of arsenic in these forms and its apparent value for tick destruction led us to try the effect of spraying the entire body with a solution of the Scrub Exterminator. On June 30th, one calf was thoroughly wetted by spraying from nose to tail tip with a solution containing one pound to eight gallons; the other with one pound to sixteen gallons. The first calf was in poor condition and suffering from a running abscess in the knee joint of its left fore leg and from an open sore under the shoulder above; the other calf was a sturdy bull in perfect health. No bad effects were observed until the third day. Then both calves were seen to be off condition. The lame one lay down that night in evident great pain; all the next day it was very bad and unable to get to his feet; on the following day it was dead. The other calf avoided company and ate sparingly for a few days and generally behaved as if ill until the seventh day, when it appeared to be practically right again. From these results we inferred that the application of Scrub Exterminator to cattle for ticks was attended with considerable risk.

Some days later while I was absent from the district, Mr. Roberts again tested the substance, using it in proportions varying from one pound to ten gallons to one pound in sixteen. This time the results lacked uniformity and were very unsatisfactory. The weather was fair as before but much colder. It looks as if the effect of arsenic on ticks may vary with the temperature, this factor acting indirectly perhaps by influencing the amount of moisture on the skin of the animal.

Smith's Scrub Exterminator and Sulphur, Uncooked.—In an old *Agricultural Journal*, Mr. A. G. Davison reports on a comparative test of arsenite of soda alone and arsenite of soda with sulphur as sheep dips. He found the latter much the better for killing scab. Thinking that the addition of sulphur might add to the killing powers of a wash containing Scrub Exterminator, we put the matter to the test by making up a wash of 14 oz of the arsenical ingredient and 34½ oz. of sulphur rubbed to a paste and diluted to 3½ gallons With this as a stock solution, we prepared dilutions containing the arsenical ingredient in the proportion of one pound to 12, 14, 18 and 24 gallons of water. With each of the first three strengths the rears and udders of three cows was sprayed and with the other dilutions, two cows. The effect on the ticks lacked uniformity and was very unsatisfactory; the strongest solution killed not over one-half while the two weakest were fatal to none. No injury was done to the cattle—or at least none was observed.

Smith's Scrub Exterminator and Sulphur, Cooked—Thinking that boiling a mixture made as the last might make some of the sulphur enter into combination with the arsenic or might render the arsenic a more active poison, the two ingredients were mixed in the same proportion and boiled hard for half an hour. The boiling, to superficial appearances, made no difference in the wash. The stock solution was

diluted so as to have the arsenical constituent present in the proportion of one pound to 12, 14, and 16 gallons of water. Each proportion was applied to two head of cattle, July 6. The weather was cold, windy, and the sky overcast part of the day. Similar weather prevailed the day before when the uncooked wash was employed. The effects were uneven and less than one-half the ticks destroyed by even the strongest solution. The sulphur evidently did not add to the value of the wash as a tick killer.

Lime and Sulphur.—Tested June 3rd. Lime and sulphur has had many published recommendations as a tick destroyer, but several farmers had told me it was quite useless. Mr. Roberts had no faith in it whatever, so we only made a small test by spraying three cows. Equal parts of sulphur and lime were boiled together as in making sheep dip, and water added at the rate of one gallon to a pound of sulphur. The hind-quarters of one cow, closely beset with almost distended blue ticks, was thoroughly sprayed with the full strength, and the hind-quarters of the two others with half strength. The sulphur showed on the hair for several days but I was unable to detect any effect on the ticks. The calf of one cow refused her suck the night after the spraying and was reluctant to take hold the following morning, nearly twenty-four hours after the application of the wash.

Soda and Sulphur.—I wrote Mr. Wm. Roe, of Graaff-Reinet, about the apparent inefficiency of Lime and Sulphur, and he suggested that soda sulphide might act where the lime sulphide failed. Accordingly I prepared a small quantity of wash, using the three ingredients at the rate of four pounds of sulphur to one of caustic soda and two gallons of water. The soda combined with the sulphur paste without heat at once, but to obtain higher sulphides, if such might form, the wash was boiled for forty minutes. Two cows were sprayed with the wash diluted with double its volume of cold water and two more with a second portion diluted with treble its volume. This brought the ratio of the sulphur to the water at one pound to one and one-half gallons, and one pound to two gallons, respectively. No effect on the ticks became noticeable. At the same time, a dozen distended female Blues were plucked from another cow and thoroughly soused in the stock solution, a dozen more at half strength, and a third dozen at quarter strength. All these ticks while still moist and highly scented with the sulphide were put aside in closed match boxes. Ten days later they were examined and without exception all were as healthy looking as could be. They were kept longer, and as many began to lay eggs, the lot was mixed with my stock ticks.

Sulphur.—On July 6th, dry sulphur was rubbed into the hair of one cow where ticks were abundant, but it had no noticeable effect. A lotion of soft grease and sulphur killed the ticks, Bont males and females and Blue females, smeared with it; but I failed to check the test by using grease alone. About two dozen female Blues were placed in a tin box on a dessertspoonful of dry sulphur. The box was tilted mouth outward and left in the sun on a window-sill. On the second day the odour of sulphur fumes was distinct. The ticks were all alive but very restless, wandering around and around the box; this may, however, have been due to the excessive light and heat. For a few days subsequently the box was kept warm on the brick work about the creamery boiler; the ticks quieted down there but showed no effects attributable to the sulphur. Then a perforated tin cover was provided for the box and the sulphur fired by dropping in a small live wood coal. The fumes ascended through the holes in the cover and therefore must have been strong for a few minutes about the ticks; nevertheless the only ticks that were killed were those scorched by the coal or which were on the portion of the sulphur which took fire. Two days later, the sulphur was fired again on the side away from where the ticks were congregated, but as before the odours failed to kill. The ticks all deposited their eggs in the sulphur and lived to die natural deaths. These tests with sulphur were very rough yet were sufficient to show that sulphur has little value, if any, as a tick destroyer.

Paraffin Emulsion.—This was prepared by myself after the Riley-Hubbard formula and was used the same day as made. Several cattle were sprayed including one which I stabled as soon as dry for my tick rearing work. I took particular care to get this one well wet and to rub in the mixture afterwards with the hand. The wash as used consisted of one part of emulsion to one of water; this made

the spray consist of one-third paraffin (White Rose Kerosene). Only one-half of the blue ticks in sight were destroyed and apparently about the same proportion of young ticks in the hair. The dead ones turned black and became hard. I had expected an unqualified success and can assign no special cause for the failure other than inefficacy of emulsified oil against ticks. We did not duplicate the experiment since in our sprayings with mechanically mixed oil and water we got good results, and because the latter method of applying oil permits of the recovery of the drippings. The cow stabled was burned by the emulsion about the neck and flanks where the application was heaviest. Her condition made her so irritable that I could not work with her.

Paraffin, pure.—Applied May 25th and June 1st. 150 test White Rose Oil was sprayed over the rears and udders of two cows I wanted for the rearing of ticks. In both cases the ticks were all destroyed. Slight inflammation was produced by the oil but this soon subsided without the cattle having appeared sensitive to it; the injury did not appear as great as that produced by the emulsion.

Paraffin with water.—From his "Success" pump and odd bits of metal, Mr. Roberts contrived an ingenious device for supplying a mixed oil and water spray; the ratio of one to the other was controlled by a screw-top to one of the valves. This pump we used in all our oil and water applications; the delivery was tested before and after each so that we might be certain of the proportion of oil delivered. The percentage of oil now to be noted are those shown by the measurement. 150 test oil was applied in percentages as follows: 5, 10, 15, 18, 22, and 27. All these sprayings were made during a spell of bright, clear days, June 19, 20, and 21. From two to seven cattle were sprayed with each of the percentages given and all were well wet. Care was taken to select cattle bearing female Bonts. The five per cent. killed few ticks; ten did much better but a few survivors were found; fifteen and all the percentages above were entirely successful with almost every beast. Two or three cattle that were sprayed with 27 per cent. showed indications of burning but the injury was very slight. The ticks died almost at once and by the following day were hard and shrivelled.

Tests to determine the comparative efficacy of fine, light spraying and forceful spraying proved the greater value of the latter. Wetting the hair only was found to leave a large proportion of the ticks unharmed. A finely broken spray delivered with sufficient force to reach to the skin was deemed the best for the purpose. Vermorel (cyclone) and Bordeaux (stop-cock) nozzles were both used, and it was hard to decide which answered best. The ideal form of spray seemed to us to be one that would strike evenly over a circular area. The cyclone nozzles deliver the liquid in a hollow cone and the stop-cock in a tringle or fan so neither is just the thing. As they come from the makers, the Bordeaux seemed to answer the better though more wasteful; but by altering the cap of the Vermorel so that the spray did not spread more than thirty degrees we became the more satisfied with it.

110 Test Oil Applied July 14th.—A series of tests with this cheaper oil was made to determine its comparative worth. Such a test had been planned before leaving Cape Town, my intention having been to conduct it with the co-operation of Dr. Dixon; but through a misunderstanding the department sent us the higher grade of oil. Subsequently I was able to obtain the low grade in Port Elizabeth and, time being short, I had it sent to Cottesbrook. Mr. Roberts alone attended to the first series of tests, I being away when the oil arrived. His mixtures showed by the settling glass, respectively, 7, 13, 15, 18, 22 and 27 per cent of oil. Six cattle were sprayed with each. The results were uniformly successful with all but the first, that of seven per cent. Fair, cool weather prevailed, and no apparent injury was done the skin of the animals.

On July 17th, I again tried the cheap oil, using 12, 15 and 20 per cent., and applying each strength to three head of cattle. The clouds hung low and rain began to fall before I had completed the spraying. The results, however, confirmed the previous work, all the proportions answering for the purpose. Our work showed that the more the percentage of oil was reduced, the more was it necessary in spraying to *thoroughly* wet the parts sprayed: for instance, although ten per cent *may be made* to kill all the ticks, the chances for some escaping through imperfect work is much greater than when fifteen per cent. is used. Mr. Roberts, I

may mention, was so pleased with the success of oil and water spraying, that he has built a cement-bottomed race and now regularly sprays his herd. He sets his pump gauge at 17½ per cent.

Other Substances.—A small-scale test of an oily bye-product from Port Elizabeth, received from Mr. Wm. Roe, of Graaff-Reinet was made, and gave indications of efficiency. The substance was almost as thick as soft soap, however, and at the value Mr. Roe mentioned for it, it could not possibly compete with paraffin. Stockholm tar and paraffin, each ten per cent. in eighty of water, acted well on the ticks and did not burn; part of one cow only was sprayed. We found difficulty in mixing the tar with the oil and hence did not follow up the test. A mixture half as strong again burned the skin slightly on two cows. Stockholm tar and caustic soda in various proportions with cold water were tried, but certain constituents of the tar remained insoluble and clogged the nozzle and pump strainer. The mixtures killed in all the percentages employed, but later we found that oil alone in the same ratio to the combined amounts of tar and water gave equally good results.

FURTHER TICK DESTRUCTION EXPERIMENTS.—MARCH, 1900.

Arsenic, Soluble, with Soap.—The experiments with soluble arsenic were prompted by the success with arsenical preparations on the former occasion of experimenting. Soap was added to better the "wetting" properties of the wash. We were further impelled to make the trials by the publication of the reputed success of a similar wash in Queensland. Our wash closely resembled "Archer's Dip," noted in the November number of the Queensland Agricultural Journal; Mr. Roberts had tried a wash made according to the formula given and had found it to be promising though not a complete success. Our wash was composed as follows:—

Powdered White Arsenic, 8 ounces; Caustic Soda, 98 per cent., 2 ounces; Bar Soap, 8 ounces; with water to mix.

The arsenic and soda were mixed together in a small quantity of water until they united in chemical combination, which they quickly did with evolution of heat; the resulting compound remained in solution and was added to a bulk of water in which the soap had been dissolved. The wash was sprayed on to the cattle and found to wet well and lather freely. As it was an entirely soluble wash its application was easy.

Diluted to four gallons, it was applied to the ventral and posterior portion of three cows. Bont, blue, and red ticks were present in numbers and all were destroyed. The effects on the ticks was noted on the following and the second day after the application. The teats of two of the cows were noticed to be sore on the following day, and on the second, the teats of all three were found to be inflamed, swollen and discoloured. The substance had evidently done injury wherever the skin had been broken and the teats had been somewhat chapped. On the fifth day after spraying all three cows were found to be suffering severely. Their limbs were stiff and swollen and they were unable to lift their tails.

Diluted to six gallons, the wash was similarly applied to three other cows. Large numbers of the same kinds of ticks were present and the destructive effects on these was complete, all including such Blues as were about to moult being killed. The teats of all three cows were similarly injured, however, and a cut in the udder of one made hard and apparently very sore. On the fifth day two of the cows appeared somewhat stiff, but all were able to get about and feed as usual.

Diluted to eight gallons, it was applied to two cows. At this strength it was also fatal to the ticks, including those Blues about to moult. No injurious action on the cows was noticeable up to the fifth day other than a slight blackening about chaps on two of the teats of one.

All the ingredients used in making this wash are cheap. A wash of the strength of the last used could be prepared at a small fraction of the cost of an efficient oil spray, and would have the additional advantage of wetting better and of being applicable with a simple form of pump. Providing no cheap, soluble, non-poisonous wash is discovered, it might be well to conduct a series of experiments with soluble arsenic and soap to determine (1) the best strength to use, and (2) the action on the animal when the applications are made over an extended period, say one year, the intervals between the sprayings being as long as possible

without permitting the dropping of mature ticks. Mr. Roberts has the facilities for such an experiment but naturally hesitates to risk his cattle and to incur the expense.

I may also mention that Mr. Roberts, during January, made several trials with soluble arsenic, and that from his results it would appear that the addition of soap greatly increases the efficiency, probably wholly by bettering the wetting capacity. He reported Archer's Dip at double strength to be fatal to half of the ticks. The formula for this is 1½ lbs. arsenic, 3 lbs. soda, 3 lbs. soap, per 100 gallons of water. Roberts's wash, therefore, contained white arsenic at the rate of 1½ lbs. to 50 gallons. The "soda" intended in the formula was presumed to be washing soda.

McDOUGALL'S SHEEP DIP, COLD WATER QUALITY.

This substance was tried because of the reputed success which several persons have reported. It mixed well with the water and had excellent wetting capacity.

One part dip to ten of water was thoroughly applied to the udder and posterior of one beast; only one, as we were afraid of damaging the skin The majority of the adult female ticks escaped, but the application was fatal to somewhat over half of the Bont males. The immature Blues on the udder were little affected, but fully three-quarters of those behind (where the hair is longer) were found to have succumbed. The skin was slightly inflamed in places.

One part dip to twenty of water was thoroughly applied to the under and rear parts of three cows. Very few of the ticks were destroyed, not over one-sixth in all; the dead were principally immature Blues, and males of the several species present. Two of the animals were somewhat burned. In explanation of the animal sprayed with the stronger mixture not being more severely burned than those sprayed with this half strength, Mr. Roberts explained that the first animal was one of a few which he had observed to escape burning when he had sprayed with strong mixtures on previous occasions.

One part dip to thirty of water was thoroughly applied similarly to three animals. A few adult males and some immature Blues were destroyed, but only a very small proportion of the whole; the adult females all escaped. One cow was burned and that almost as much as the animals sprayed with the one part in twenty.

CHAS. P. LOUNSBURY.

APPENDIX B.—Nursery Inspection and Quarantine Bill.

Draft supported by Boards of Horticulture.

BILL

TO

Check the Dissemination of Insect Pests or Plant Diseases from Nurseries of Plants and Trees.

Preamble.—Be it enacted by the Governor of the Cape of Good Hope, with the advice and consent of the Legislative Council and House of Assembly thereof, as follows:—

1. *Repeal of Repugnant Laws.*—So much of any law as may be repugnant to or inconsistent with the provisions of this Act is hereby repealed.

2. *Interpretation Clause.*—For the purposes of this Act the following terms within inverted commas shall, if not inconsistent with the context and subject matter, have the meanings hereby respectively assigned to them; that is to say:—

"Nursery" shall mean any land or premises whereon are grown or cultivated any fruit or other trees, perennial shrubs or plants intended for sale or distribution for the purpose of being grown elsewhere.

"Insect Pest" shall signify any insect which the Governor may from time to time by proclamation declare to be an insect pest within the meaning of this Act.

"Plant Disease" shall mean any fungoid or other disease which the Governor may from time to time by proclamation declare to be a plant disease within the meaning of this Act.

3. *Registration of Nurseries.*—Every nursery shall be registered by the owner or occupier thereof, at the office of the Resident Magistrate or Assistant Resident Magistrate of the district wherein such nursery is located, on or before the 15th of January in each year; and a general registration fee of £1 per annum shall be paid by the owner or occupier in respect of any nurseries owned or occupied by him in such district.

4. *Inspection of Nurseries.*—Every nursery shall be inspected at least twice a year by an officer appointed for the purpose by the Minister; but, unless deemed absolutely necessary by the Minister, no inspection shall be made during such period between 1st of May and 1st of October, as shall be fixed for the different areas by proclamation by the Governor.

5. *Duty of Inspector.*—It shall be the duty of the inspecting officer to declare under quarantine such part of any nursery as lies within eight (8) yards of any tree or plant which he finds infested with any insect pest or plant disease, or within twelve (12) yards if such infested tree or plant is over ten (10) feet in height; and such area shall be held and deemed to be under quarantine accordingly.

6. *Quarantine, Continuation of.*—A quarantine proclaimed under the preceding section shall remain in force until the inspecting officer shall at a subsequen regular inspection, or at an authorized examination as provided for in section 7 hereof, find the trees or plants within such quarantined area free from insect pest or plant disease, and shall have given his written certificate to that effect to the owner or occupier of the nursery affected; and during such period of quarantine it shall not be lawful for any person to remove or cause to be removed any nursery stock or any plant or any portion thereof from the quarantined area.

7. *Authorized Examination.*—Any owner or occupier of a nursery having his nursery or any part thereof thus placed under quarantine, may, upon application to the Minister, have his nursery examined free of charge prior to the next regular inspection, to determine whether or not he has been successful in eradicating the insect pest or plant disease, but such owner or occupier must certify that a period of six weeks has elapsed since the last application of the remedy. If additional examinations are desired, they will be made under the same conditions, but at the expense of the owner or occupier; and any person who shall give a false certificate under this section shall be deemed to be guilty of a contravention of this Act.

8. *Destruction of Plants, &c.*—Nothing in the foregoing sections shall prevent any inspecting officer from ordering and causing to be carried into effect the immediate destruction of any plants or trees in any nursery which he finds infested by any insect specially dangerous, or other animal pest, or by any plant disease, whether the same has been proclaimed or not proclaimed as such under section 2 of this Act, should he deem such action advisable; provided, however, that any dispute as to the justification of such a measure shall be referred for decision to a committee composed of three members, one of whom shall be appointed by the Secretary for Agriculture, one by the Horticultural Board, and one by the local Fruit Growers' Association, or should no such society exist in the district, by the local Agricultural Society, or in default of such Agricultural Society by the Horticultural Board. Neither the inspecting officer nor the owner or occupier concerned shall be eligible for appointment on the said committee. The decision of the committee must be given within three weeks, and shall be final; and until such decision has been obtained the infested portion or portions of the nursery shall be declared and held to be under quarantine as provided for in Section 5 of this Act.

9. *Entry upon Lands.*—It shall be lawful for any officer duly appointed thereto by the Minister, to enter upon any land, and to do thereon such acts, matters and things as are necessary or reasonably required for carrying out the provisions of this Act and any person obstructing, resisting or interfering with any such officer in the lawful execution of his duty, shall be deemed to be guilty of a contravention of this Act.

10 *Rules and Regulations.*—It shall be lawful for the Governor by proclamation to make, alter or revoke such rules and regulations for the purpose of carrying out

the provisions of this Act as may from time to time be deemed expedient, and impose penalties for the contravention thereof not exceeding a fine ——

11. *Penalty Clause.*—Any person contravening any of the provisions of this Act, or of any rule or regulation duly made and published thereunder, shall be liable to the particular penalty on that behalf prescribed, or if no particular penalty be prescribed, then to a penalty not exceeding ——

12. *Short Title.*—This Act may be cited as "The Nurseries Inspection and Quarantine Act, 1897."

APPENDIX C.

BILL

TO

Prevent the Spread of Plant Pests and Diseases.

Drawn up by the Board of Horticulture for the Western Districts, and printed for distribution among Fruit Growers' Associations for their observations and suggestions.

BE it enacted by the Governor of the Cape of Good Hope, with the advice and consent of the Legislative Council and House of Assembly thereof, as follows :—

1. So much of any law as may be repugnant to or inconsistent with the provisions of this Act is hereby repealed.

2. For the purposes of this Act the terms "plant pest" and "plant disease" shall signify any pest or disease injurious to cultivated plants which, upon the recommendation of the Horticultural Commission hereinafter referred to, shall by Proclamation in the *Gazette* be declared as such in the district or ward for which such Horticultural Commission has been appointed.

3. The provisions of this Act shall be in force in such districts, or wards of a district, as the Governor may by Proclamation in the *Gazette* prescribe, except sections 8 and 12, which will be in force throughout the Colony: provided that no such Proclamation shall issue in respect of any district or ward, except upon the recommendation duly made in writing of the local fruit growers' association or agricultural association in such district or ward: and provided further that it shall be lawful for the Governor, upon a like recommendation, to revoke any Proclamation issued in respect of any district or ward, and thereupon the provisions of this Act shall no longer be in force in such district or ward.

4. Upon the provisions of this Act being put into force in any district or ward, a Horticultural Commission shall be appointed by the Minister for Agriculture, consisting of three persons, being *bona fide* fruit-growers, one person to be selected by the Resident Magistrate of the district, and two persons to be selected by the local fruit-growers' association or agricultural association. Should such association be represented on the Board of Horticulture, then one of the persons to be selected by such association shall be one of the members representing such association upon the Board of Horticulture. The Horticultural Commission shall be appointed biennially, the retiring members to be eligible for re-election.

5. Such Horticultural Commission shall, as soon as may be after being so appointed take steps to appoint an inspector or inspectors, subject to the approval of the Government, whose duty it shall be to ascertain and verify the existence of any plant pest or disease in the district or ward for which such Commission has been appointed.

6. Whenever it shall be proved to the satisfaction of such Commission that any proclaimed pest or disease exists on any tree or plant on any property or place within such district or ward, and they shall be of opinion that such pest or

disease threatens or is likely to spread and be injurious to other trees and plants. It shall be the duty of such Commission to give notice to the owner or occupier of such property or place to take such steps as the Commission may prescribe for dealing with such pest or disease, within a given period to be fixed by the Commission: and in default of any such owner or occupier taking such steps for dealing with the said pest or disease within the period prescribed, it shall be lawful for the Commission to take all necessary steps and to deal with such pest or disease: the cost attending the steps taken by such Commission shall in the first instance be paid out of the public revenue, and shall be recovered from such owner or occupier in any court of competent jurisdiction.

7. Notwithstanding the provisions of the preceding section set forth, it shall be lawful for the owner or occupier of the place or property on which the pest or disease exists, before the Commission commences to take steps for destruction or disinfection, but not otherwise, to notify to the Commission his intention to appeal direct to the Minister against the decision of the Commission, and to appeal accordingly: and upon receipt of his notification the Commission shall abstain from taking any further action until their recommendations have been approved, modified or disallowed by the Minister, and the decision of the Minister in the case shall be accepted as final: provided that if the owner or occupier does not file his appeal within one week from the date of his notification to the Commission, it shall be lawful for the Commission to proceed with the eradication and cure as if such notification had not been made.

8. Notwithstanding anything contained in the preceding sections, it shall be lawful for the Minister, whenever he has reason to believe that any specially dangerous plant pest or disease exists in any district, whether or not such pest or disease has been proclaimed under Clause 2, to inspect or direct the inspection of any property or place in which the pest or disease is alleged to exist and to take such steps as he may deem necessary for the suppression of such pest or disease.

9. It shall be lawful for any such Commission or any person duly authorised by such Commission to enter upon any lands and to do thereon such acts, matters and things as are necessary or reasonably required for carrying out the provisions of this Act.

10. It shall be lawful for such Horticultural Commission to frame such regulations under this Act as it may be necessary to make from time to time, such regulations to be submitted to the Governor for approval, and to come into force on promulgation in the *Government Gazette*.

11. Every person contravening any of the provisions of this Act or any Proclamation issued thereunder, or any regulation made by the Governor thereunder, shall be liable to the penalty specially prescribed for such contravention, and where no such penalty has been specially prescribed to a fine not exceeding £.....

12. From and after the date of the promulgation of this Act, it shall not be lawful for any person to sell or cause to be sold on any public market in the Colony or to transport or cause to be transported by any public conveyance any fruit infested with Codling moth or living scale. Any person contravening or causing to be contravened the provisions of this section shall be liable upon conviction to a fine not exceeding £.....

13. This Act may be cited as "The Plant Pest and Diseases Act, 1900."

APPENDIX D.—Import Regulations.

Draft of Schedule recommended by Board of Horticulture, April, 1900.

1. The importation of the following articles is hereby prohibited:—

(*a*) Grape vines or any portion or fruit of any grape vine, with the exception of vines or portions thereof imported by the Government under such precautionary measures as it may deem necessary.

(*b*) Coffee plants or any portion thereof, with the exception of seed.

(*c*) Stone-fruit trees or any portion thereof, including seeds that were grown or produced in any state, province or territory of the United States of America or the Dominion of Canada, in which either of the diseases known as Peach Yellows or Peach Rosette exists.

(*d*) From and after the 1st March, 1901, the importation of peach stocks and peach stones from any country whatsoever, shall also be prohibited.

2. The importation of any fruit tree or portion thereof, with the exception of fruit and seed, seedling stocks for budding or grafting purposes, and blight-proof stocks for apples excepted, shall be permitted only under the following conditions:—

(*a*) A special permit must, previous to importation, be obtained from the Department of Agriculture, in which is stated fully the number and description of trees it is desired to introduce and from what locality and from whom they are to be procured.

(*b*) No one shall be allowed to import more than ten trees or separate parts of trees of any one variety, or more than a total of one hundred trees or parts of trees during one year.

(*c*) Importation shall be restricted to varieties not catalogued by and procurable at a reasonable rate from any Colonial nurseryman.

(*d*) In the case of rooted trees, such articles must be accompanied by a sworn declaration from the consignor that they were carefully examined at the time of packing, and found entirely free from boring insects.

(*e*) In the case of stone-fruit trees, or portions of seed thereof, such articles must also be accompanied by a sworn declaration from the consignor that they were not grown nor produced from seed grown nor packed in any state, province or territory of the United States of America or Dominion of Canada, in which either Peach Yellows or Peach Rosette exists.

3. All trees and plants and portions thereof, such as cuttings, roots, tubers and bulbs, and fruit of all kinds, and their packages, cases, pots or other coverings, shall, before being introduced into this Colony, undergo an examination by an officer appointed for that purpose, to determine as far as possible whether or not insects or plant diseases are present; and it shall be the duty of the consignee, or his duly appointed agent, to open the coverings and to afford every facility to the Examining Officer during the examination.

4. Should any of the articles defined in the preceding clause be found on examination to be infected in whole or in part with any insect or plant disease whose introduction would be prejudicial to the interests of the Colony, they shall, together with their covering and packing material, be cleansed or disinfected by the consignee, or at his expense, in the manner prescribed by, and to the satisfaction of the Examining Officer; and, if not so cleansed or disinfected, or if the treatment shall be deemed or found to be ineffectual to eradicate the insect or disease, the articles shall be destroyed without delay.

5. All trees and portions thereof, together with their coverings and packing material, shall, whether or not any insect or plant disease is discovered in the examination provided for in clause 3. be fumigated at the expense of the consignee in the manner prescribed by and to the satisfaction of the Examining Officer.

6. On the aforesaid Examining Officer being satisfied with respect to a consignment that all the regulations and conditions herein set forth have been fully complied with, he shall issue a certificate to that effect to the consignee; and, before the issue of such certificate, the landing or attempted landing of such consignment shall constitute a violation of these regulations.

7. Articles subject to examination under these regulations, introduced into this Colony by post, shall be intercepted and examined by an officer appointed for the purpose; and, if found infested with any noxious insect or plant disease, shall be destroyed or cleansed at the discretion of such Examining Officer, and, if requiring fumigation, shall be so treated. All expenses of treatment shall be borne by the addressee.

8. The Government does not hold itself responsible for any loss or damage that may result from the destruction of articles under these regulations, or from any process that may be considered necessary to cleanse or disinfect the articles, or to discover the existence or otherwise of any insect or plant disease.

9. These regulations shall not apply to canned, dried or otherwise preserved articles, in which there is no longer any plant life.

[G. 36—1900.]

Explanation of Plate I.

Harpuis Bosch Scale, *Asterolecanium* n. sp.

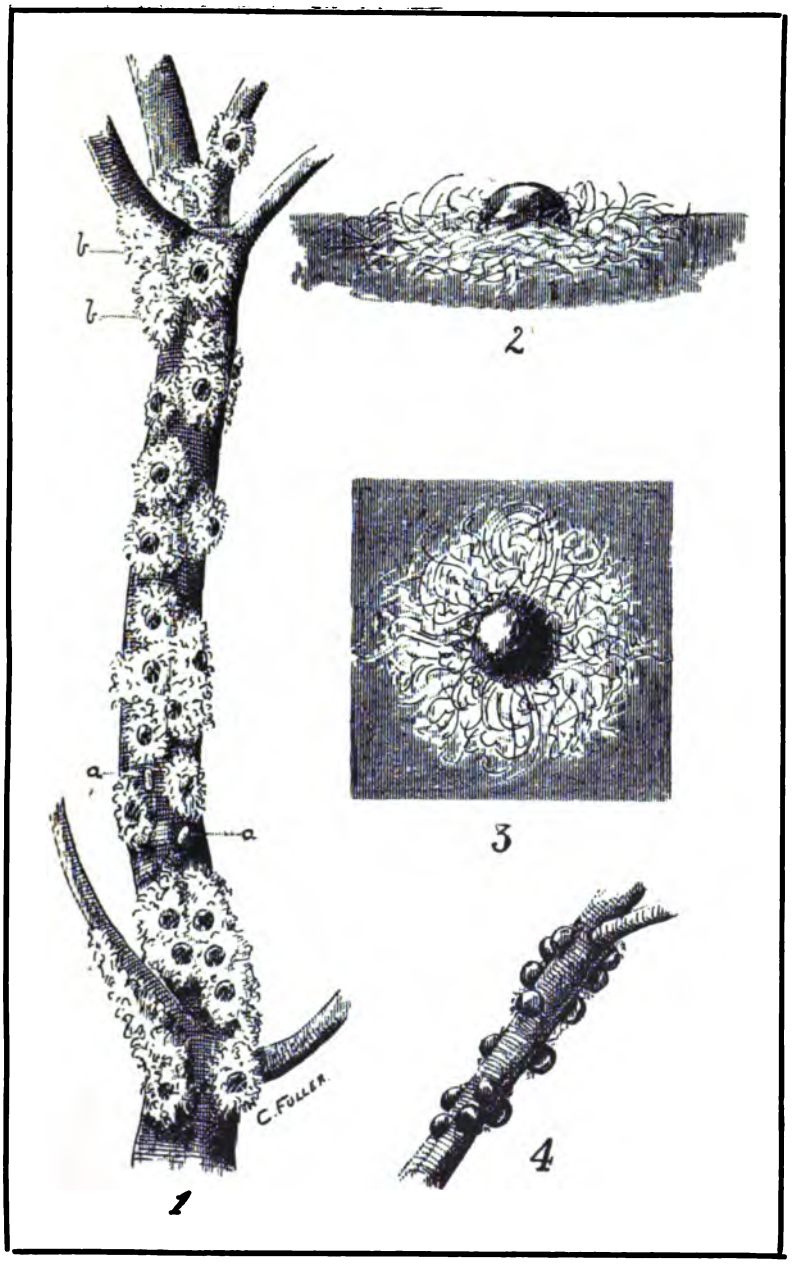
1.—Infested twig of Harpuis Bosch, *Euryops tenuissimus* Less. *a*, *a*, male scales. Slightly enlarged.

2.—Adult female scale, side view. Greatly enlarged.

3.—Adult female scale, top view. Greatly enlarged.

4.—Twig showing scales with floss removed. Slightly enlarged.

PLATE I.



Claude Fuller, del.

Explanation of Plate II.

Fowl Midge, *Simulium* sp.

1.—Adult. Enlarged and natural size.

2.—Larvæ attached to a grass root. Natural size.

3.—Piece of broken china with eggs and pupæ attached. Enlarged.

4.—Twig encrusted with cocoons. Natural size.

5.—Pupa. Enlarged.

6.—Larva. Greatly enlarged.

7.—Same, side view.

PLATE II.

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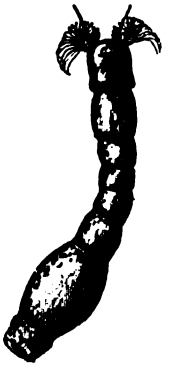

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Claude Fuller, del.

Explanation of Plate III.

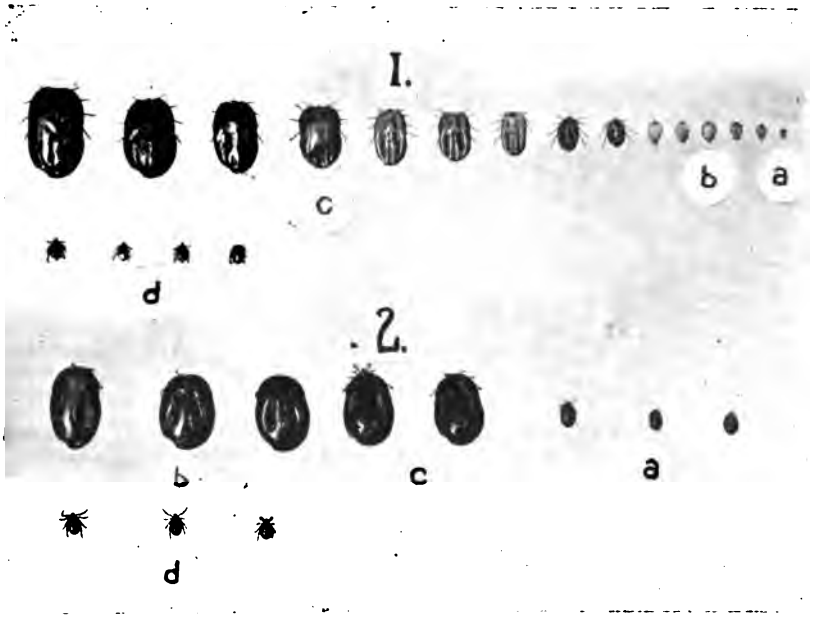
1. Blue Tick, *Rhipicephalus decoloratus*, Koch: *a*, engorged larva; *b*, nymphs in various degrees of engorgement to full size; *c*, females in various degrees of engorgement to full size; *d*, males, full size. All natural size.

2.—*Ixodes pilosus*, Koch: *a*, engorged nymphs; *b*, engorged females; *c*, engorged females from beneath showing males attached; *d*, males, full size. All natural size.

3.—Bont Tick, *Amblyomma hebræum*, Koch. Female before feeding. Enlarged four times.

4.—Bont Tick, *Amblyomma hebræum*, Koch. Male. Enlarged four times.

Figs. 1 and 2 from photograph by G. S. Bettison.
Figs. 3 and 4 from photograph by E. J. Wheler.



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Explanation of Plate IV.

1.—Bont Tick, *Amblyomma hebræum*, Koch: *a*, engorged larvæ; *b*, engorged nymphs; *c*, engorged females; *d*, males. Natural size.

2.—Red Tick, *Rhipicephalus evertsi*, Neumann: *a*, engorged larvæ; *b*, engorged nymphs; *c*, females, before feeding; *d*, same, engorged; *e*, males. Natural size.

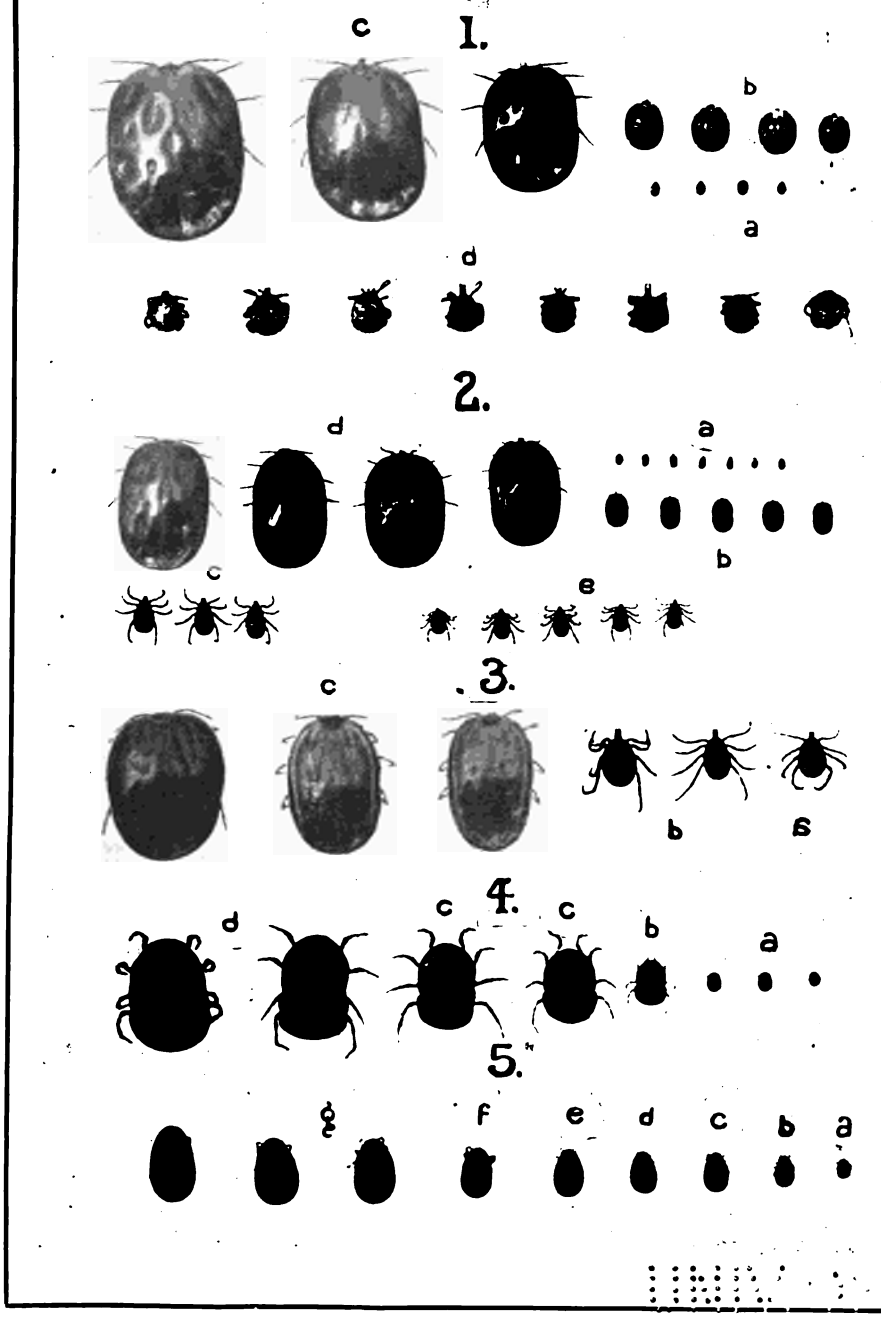
3.—Bont Leg Tick, *Hyalomma ægyptium*, Audouin: *a*, male; *b*, females, before feeding; *c*, same, engorged. Natural size.

4.—*Onithodoros savignyi*, Audouin: *a*, nymphs; *b*, male; *c*, females, before feeding; *d*, same, after feeding. Natural size.

5.—Fowl Tick, *Argas persicus*, Fischer: *a*, larva, after feeding; *b*, first nymph stage, after feeding; *c*, second nymph stage, after feeding; *d*, male, before feeding; *e*, male, after feeding; *f*, female, before feeding; *g*, females, after feeding. Natural size.

From photograph by G. S. Bettison, Capetown.

PLATE IV.



INDEX.

A.

	PAGE
Aberdeen	12
Acacia giraffe, Cameel Doorn	37
,, horrida, over-numerous	38
Adelaide, Cape Colony	25, 32
Agricultural Journal:	
Blue Tick, notes on	38
contributions to	4, 21
Harpuis Bosch Scale, article on	38
Agriculture, Minister for	10
Alnwick, England	32
Amblyomma devium	32
,, hebræum. (See Bont Tick)	
America	12, 30
American blight, or woolly aphis	4
Ants	4
Aphis, cabbage	4
mali	3
on peach trees	4
ribis, eggs of	3
woolly	4
Appendix A, Tick Destruction Experiments	40
,, B, Nursery Inspection and Quarantine Bill	45
,, C, Prevent spread of Plant Pests and Diseases	47
,, D, Import Regulations	48
Apple aphis	3
scions from Ireland	2
Archer's dip	44-5
Argas persicus, fowl tick	Plate IV., 33
Arsenical poison for pear slug	37
Arsenic for tick destruction—	41
soluble with soap—similar wash in Queensland	44
,, ,, resembles Archer's dip	44
Arsenious sulphide in Cooper's dip	40
,, oxide ,, ,,	40
Arsenite of copper, substitute for Paris green	37
Artist, resignation of	6
Aspidiotus aurantii	9
Asterolecanium n. sp., harpuis bosch scale	Plate I., 38
Australia	12, 30
Australian bug	5

B.

Bagrada bug	4
Bag-worm, wattle	4
Bean bruchus	4
Bechuanaland	33
Bed bug	17, 33
Bedford, thorn trees at	37
Blight, American, or woolly aphis	4
Blue tick, common, of Cape Colony	4, 21, 28-30, 32, 44-5, Plate III.
Blue, Larger	29

[G. 36—1900.]

PAGE
Board of Horticulture 36
Western Province 1, 4, 6, 10
Eastern Province 1, 6, 10
Bont Tick..... Plates III. and IV., 2, 4, 20, 21, 24, 26, 27, 29, 30, 32, 40, 44, 45
Bont-leg Tick ..... Plate IV., 20, 27-30, 32
Bont-legged, bont-backed tick on tortoise 32
Boophilus bovis 30
Bordeaux nozzle in spraying for ticks 43
Borthwick, Veterinary Surgeon 24
Bulbs from England 2

C.

Cabbage Aphis 4
Cameel Doorn, Acacia giraffe, destroyed by L. mimosæ 37
Cattle 30
Canada, Dominion of, importation from prohibited 48
Cape Peninsula, codling moth at 34
Cape Town, codling moth and fruit fly at 34-6
Ceratitis capitata, fruit fly 35
Ceylon, ladybird introduced 12
Chief Justice Sir J. H. de Villiers 34
Claremont 34
Codling moth 4, 10
,, ,, at Constantia 34
,, ,, at Cape Peninsula 34
Coffee plants, importation prohibited 48
Commissions, Horticultural 10
Constantia, codling moth at 34
Cookhouse, fruit fly in prickly pears at 36
Cooper's dip, for ticks 40
arsenious oxide in 40
,, sulphide in 40
sodic sulphide in 40
sulphur in 40
Correspondence 3
Cottesbrook, Adelaide, C.C 21, 40
Currant Aphis, eggs of 3
cuttings from England 3
Scale 3
Cyanide of Potassium 16, 18

D.

Davidson, Dr., of Adelaide, C.C. 32
Davidson, A. G., tests arsenites for sheep dips 41
De Villiers, Sir Henry 34
Dixon, Veterinary Surgeon 24, 25, 30, 40
Douglass, A. W. 32
Drostdy Gardens, Worcester 36
Ducks dying from ticks 33
Du Plessis, F. J. 24

E.

England, Alnwick 32
bulbs from 2
currant cuttings from 3
gooseberry cuttings from 3
Entomologist, Assistant, articles by 4, 38
Resignation of 6

PAGE

Entomologist of Florida 37
of Natal 34
Eriocampoides limacina, Pear Slug 36
Europe, Prickly Pear and Fruit Fly in South of 36
Euryops tenuissimus, Harpuis Bosch 38
Examination of Nurseries authorized 46
Exhibition, South African 1
Exochomus nigromaculatus 12

F.

Farmers' Conference, Grahamstown 1
Congress, Annual 1
Findlay and Co., Cape Town 37
Fish netting for birds 36
Florida, Sphærostilbe coccophila in 37
State Entomologist of 37
Fort Beaufort, thorn trees at 37
Fowls dying from ticks 33
Fowl Midge, Simulium sp. ..... Plate II., 38
at Wynberg 39
Fowl Tick, Argas persicus ..... Plate IV., 4, 33
Frost, W., Thibet Park, Tarkastad 38
Fruit Fly, Ceratitis capitata 4, 10, 35
in prickly pear 36
netting for 36
Formaldehyde gas for railway carriages 17
Froggatt, W. W. 12
Fuller, Claude 5, 12, 20
articles by 4, 38
investigating fowl midge 39
entomologist of Natal 37
Fungus, for Red Scale 37
Fumigation of Dwelling-houses 19
orchards 15
co-operative 15
railway carriages 17
"Table of Quantities" 16

G.

Gas treatment 18
" " notes 15
German South-west Africa 33, 37
Glanville, O. H. 25
"Glass-eye" Birds 36
Goudini, Rawsonville Farm 36
Gooseberry cuttings from England 3
Graaff-Reinet 34
Grain Bug 4
Grahamstown 32
Grape-vines, importation prohibited 48
Guinea pigs for ticks 20

H.

Harpuis Bosch, E. tenuissimus ..... Plate I., 38
natural enemies 4
Scale, Asterolecanium n. sp. ..... Plate I., 38
Heartwater 2, 19, 24
Heatherton Towers 32

INDEX

PAGE

Hellebore, black 37
white 37
Helleborus niger 37
Holy Land, lemons from 3
Horticulture, Board of 36
Eastern Province 1, 6, 10
Western Province 1, 4, 6, 10
Horticultural Commissions 10
Houses, fumigation of 19
Hurndall, R. F. 28
Hutcheon, Dr. D. 2, 21, 24, 40
Hyalomma ægyptium. (See Bont-leg Tick.)
Hydrocyanic Acid Gas 9-17

I.

Import regulations 2, 11, 48
Insect pests, origin and means for their suppression 4
meaning of 45
friends and foes 4
legislation 6
notes, miscellaneous 34
pest bill and plant disease 10
Inspector, duty of 46
Iowa 6
Ireland, apple scions from 2
Ixodes pilosus ..... Plate III., 32
reduvius 32

J.

Justice, Chief, Sir Henry de Villiers 34

K.

Karroo, complaints from 19, 38

L.

Ladybirds, introduction of new 5, 12
Lands, entry upon 46
Larger Blue Tick 29
Lecaniodiaspis mimosæ = Prospophora prosopodis, var. mimosæ, Maskell 37
Lecanium hesperidum 2
ribis 3
Legislation, insect 6
Leis conformis 13, 15
Lemons from Holy Land 3
Le Souef, A. 13
Lesseyton, Harpuis Bosch pestiferous at 38
Lice, Pig, *alias* tampans 4
Lime and sulphur for ticks 42
Locusts, spraying with paraffin 4
Lounsbury, C. P. 40, 45
McDougall's sheep dip 45
McMillan, B., observed fowl midge 39
Mally, C. W. 6
Mealies in Iowa 6
Medlar trees, pear slug on 36
Mellish, E. H. F. 20
Minister of Agriculture 10
Miscellaneous insect notes 34

PAGE
Moravian, Captain of 13
Mytilaspis citricola 9
pomorum 2

N.

Natal, Government Entomologist of 7, 12, 34
fruit fly, netting in 36
codling moth in 34
Netting, for Fruit Fly 36
fish, for birds 36
New Bethseda 34
New South Wales Government Entomologist of 12
Neumann, Prof. G. 23, 30, 32, 33
New York, otaheita orange from 2
Nurseries bill 6, 9
inspection and quarantine bill 45
meaning of 45
registration of 46
inspection of 46

O.

Oenopia cinctella 14
Office, visitors to 3
Ohio Experiment Station 6
Oil, bye-product for ticks 44
Onithodoros savignyi ..... Plate IV., 33
Orcas chalybæus 12
Orchard fumigation 15
Orange aphis 13
Orchard pest bill 9
Orthesia insignis 37
Other substances for ticks 44
Otaheita orange from New York 2
Oudtshoorn 33
Oyster shell bark louse 2

P.

Paarl 34
Paraffin emulsion for ticks 42
pure, for ticks 43
spraying locusts with 4
and water for ticks 43
Paris Green, arsenite of copper, substitute for 37
Parlatoria, sp., on otaheita orange 2
Peach trees, aphides on 4
yellows, reference 48
rosette 48
Pear Slug 9
on medlar trees 36
Peninsula, Cape, codling moth at 34
Persia, Argas persicus in 34
Pigeons, fowl ticks on 34
Pig lice, *alias* tampans 4
Pillans, E. 21
Plants, destruction of 46
Plant disease and insect pest bill, 1895 10
Plant disease, meaning of 46-7
Plant pest, meaning of 47
Plant pests and diseases, prevention of spread 47

PAGE
Plumbago, Vedalia in 5
Portuguese East Africa..... 33
Potassium cyanide 16, 18
Post Office examinations 2
Poultry pest, a new 4
Prickly pear, new food plant for fruit fly 36
Publications.. 3
Puff Adder, ticks on 32
Purple scale on citrus trees 9
Prospophora prosopodis, var., mimosæ, Maskell = Lecaniodiaspis mimosæ.. 37

Q.

Quarantine bill, nurseries inspection and 45
Quarantine, continuation of..... 46

R.

Railway carriage fumigation 17
Rawsonville, Goudini, farm..... 36
Red Scale..... 9, 15
letters of inquiry..... 37
fungus 37
Red Tick, Ripicephalus evertsi ..... Plate IV., 24-6, 29, 30, 32, 44
Red-water, transmission of 2, 24
Rhipicephalus annulatus 30
bursa..... 29, 32
capensis..... 32
decoloratus. (See Blue Tick.)
evertsi. (See Red Tick.)
Rhodesia 33
Rich, Arthur 6
Robertson & Co., James, Cape Town 16
Roberts, L. J., Cottesbrook, Adelaide 1, 21, 25, 32, 40, 42, 43
Roe, William, Graaff-Reinet 42-4
Rolfs, P. H., Florida State Entomologist..... 37

S.

Scale insects 37
Schild pad, ticks on 32
Sesia tipuliformis 3
Simonsberg, codling moth 34
Simondium 34
Simpson, Captain 13
Slugs, in consignment from England..... 3
Simulium, sp., fowl midge ..... Plate II., 4, 38
Smith's scrub exterminator for ticks 40
,, ,, ,, and sulphur, uncooked 41
,, ,, ,, ,, cooked 41
Snake, ticks on 32
Sneeuwbergen, harpuis bosch pestiferous 38
Soap, arsenic, soluble with 44
Soda and sulphur for ticks 42
Sodic sulphide in Cooper's dip 40
Somerset East, angora goats from 24
Somerset West, codling moth at 34
Sphærostilbe coccophila on red scale in Florida 37
,, ,, ,, Natal..... 37
Spraying locusts with paraffin 4
,, winter 4
Spreull, Assistant Veterinary Surgeon 24

PAGE
State Entomologist of Florida, P. H. Rolfs 37
Stellenbosch, R.capensis at 32
,, codling moth at 34
Stone fruit trees, importation prohibited 48
"Success" pump for spraying 40, 43
Sulphur in Cooper's dip 40
for ticks 42
Smith's scrub exterminator and 41

T.

Table of quantities in fumigation 4, 16
Tampans or fowl ticks 4
Pig lice, *alias* 4
Tarkastad, Thibet Park 38
Thorn tree scale, L.mimosæ 37
Tick destruction experiments, Appendix A. 40
Tick investigations 1, 19
Ticks, other, from farm animals 32
Tortoise, bont-legged, bont-backed tick on 32
Transvaal, tampans at Zeerust: 33

U.

United States of America, importation from prohibited 48
Government favours arsenite of copper 37

V.

Vedalia, distribution of 5
Veld-usurping bosch, Euryops tenuissimus 38
Veratrum album, white hellebore 37
Vermorel nozzle in spraying for ticks 43
Veterinary Surgeon, Colonial 2, 21, 30, 40
Visitors to the office 3

W.

Woolly aphis or American blight 4
Wandluis or fowl ticks 33
Warrambool, Captain of 13
Watermeyer, J. C., Windhoek, German South-west Africa 37
Wattle bag-worm 4
Webster, F. M. 6
Weir, Richard, collected ladybirds 13
Wellington, codling moth at 34
Western Province, codling moth in 34
red scale in 37
Wheler, E. J., observations on ticks 32
Windhoek, German South-west Africa, tampans from 37
Worcester, Dro-tdy Garden, pear slug at 36
Wynberg, codling moth at 34
fowl midge at 39
Winterbergen, harpuis bosch pestiferous in 38

Z.

Zeerust, in Transvaal, tampans from 33
Zosterops sp., "Glass-eye" birds 36
Zwart Ruggens, heartwater likely to spread to 25

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

YEAR 1899.

CAPE OF GOOD HOPE.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1900.

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Cape Town, 28th March, 1901.

THE HONOURABLE THE SECRETARY FOR AGRICULTURE.

SIR,—I have the honour to present herewith my report for the year 1900. Your especial attention is earnestly requested to the passages under the heading "Insect Legislation," and I sincerely hope that you will be disposed to exert your influence in securing to our horticulturists the much needed measures therein discussed. It is particularly pressing that we have a system of inspection for nurseries of plants and trees and prohibition in some form on the sale of stock infested with pernicious insects.

CHAS. P. LOUNSBURY, B.Sc., F.E.S.,
Government Entomologist.

TABLE OF CONTENTS.

Letter of Submittal. PAGE

PART I.

General Statement 1

Tick-Heartwater Investigations 2
Bont Tick found to transmit Heartwater Infection.
Possibility of ridding Veld of Infection.
Further Investigations Planned.

Beneficial Insects 4
Introductions of Ladybirds
Exportation of Scale Parasites to California.
Exportation of Ladybirds to Ascension.
Distribution of Vedalia.

Hydrocyanic Acid Fumigation 7
Orchard Fumigation.
Fumigation of Gaols.

Minor Investigations 8

Examinations of Plant and Fruit Imports 8
Post Office Examinations.
Dock Examinations.
Some Notorious Pests Stopped.

Correspondence and Publications 10
List of Contributions to Agricultural Journal.

Acknowledgments 10

PART II.

Tick-Heartwater Experiment 12
Plan of the Work.
Infection of the Ticks.
Recovery of the Ticks.
Tick Infection of Susceptible Goats.
Results of Bont Tick Infection.
Results of Red Tick Infection.
Discussion of Results.
Conclusion.

Natural Enemy" Enquiries, and Ladybird Introductions 22
Explanatory.

Red Scale 23
Standing in California.
Doubt that efficient Natural Enemies anywhere exist.
Search for Enemies in Australia.
Californians sanguine of Success.
Southern Europe may have efficient Enemies.
Fungus Parasite in Natal, Ceylon, and Queensland.

PAGE

Introductions of Aphis-Feeding Ladybirds 27
Relations of Aphides to their Foes.
Ladybirds sent from America.
Treatment of the Importations.
Bacterial Disease of Ladybirds.

Introductions of Scale-Feeding Ladybirds 34
Kinds sent from California.
Cryptolæmus montrouzieri successfully colonised.
Progress with other Species.
Difficulties in utilizing Natural Enemies.

Insect Legislation 39

Nurseries Bill.
Plan and Urgency of the Bill.
Fruit Growers largely indifferent to their Interests.
Recommendations should Bill be rejected.

Orchard Pest Bill 41
Action of Boards of Horticulture in relation to.
Plan of, and Necessity for, the Bill.
A compulsory Measure undesirable.
Analogous Legislation in California.

Import Regulations. 44
Outline of proposed Amendments.
Objections by Eastern Province Fruit Growers.

Miscellaneous Insect Notes 46

Codling Moth.
Firmly established in south-western fruit Districts.
Eastern Province Growers urged to look out for it.

Fruit Fly 47
Relative Scarcity last Year.
Related Species in Natal.
Related Species in Suburbs near Capetown.

Fruit Moth 48
Extraordinary Abundance.

Grain Bug 49

Heliothis armiger 50
Heavily parasitized this year.

Diamond Back Moth 50
Affected by Fungus Disease and Parasites.

Loquat Worm 51
Affecting Grapes in Constantia.

Pea Aphis 51
Identical with European Form.
Fungus Disease which destroys.

Orthezia insignis 52
Found in Capetown Suburbs in Lantana Hedge.

Other Scale Insects 53
Grape Mealy Bug.
Pineapple Mealy Bug.
Coccid on Grape Roots.

PAGE

Locusts 54
Need of Legislation.
Fly Parasites abundant.

Appendix A.—Draft of Nurseries Inspection and Quarantine Bill .. 56

Appendix B. –Draft of Plant Pests and Diseases Bill 57

Appendix C.—Draft of Proposed Schedule of Import Regulations .. 59

Appendix D.—Temperature Records of Goats used in Tick-Heartwater Experiments 61

Charts showing Temperature Records for part of Period.

Illustrations.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1900.

Presented to both Houses of Parliament by command of His Excellency the Governor.
1901.

GENERAL STATEMENT.

The plan of work for this office outlined at some length in the writer's Annual Report for 1898 is still followed. In addition to the work that has become routine, such as attention to enquiries concerning insect pests, inspection of plant imports, and so on, one or more special lines of investigation have been kept continually in progress to ensure there being some material accomplishment at the close of the year to demonstrate the utility of the sub-department. The work was somewhat broken during the period to be covered by this report by the writer's absence from the Colony on leave from May to November; but during the interval the regular and much extra work was ably conducted by the newly-appointed Assistant Entomologist, Mr. C. W. Mally. Moreover, whilst the writer was visiting the United States he devoted considerable time to entomological work, in part at the request of the Department, which will properly find a place of mention. As in previous years the general report, under the caption "General Statement," will be supplemented by an extended consideration of the more important work in hand or accomplished during the year, and pertinent remarks on some subjects, as horticultural legislation, bearing broadly on applied entomology for the benefit of our agriculturists.

Tick-Heartwater Investigations.—The preparation for and conduct of experimental research to establish the connection, if any, between tick parasites and the heart-water disease of sheep and goats has had attention throughout the year, and results of considerable importance have been attained. Research in the particular line was suggested by the findings of Government Veterinarian Dixon in regard to the contraction of the disease on the veld independent of food and drink (see *Agricultural Journal*, June, 23, 1898), by the popular notion amongst farmers that the Bont Tick was concerned (for instance, see evidence of Mr. J. Webb before Cattle Diseases Commission, 1876), and by sundry facts that came under the writer's observation whilst elucidating the life history of the Bont Tick at Fort Beaufort in 1899. Indications that the Bont Tick was concerned were determined in a minor experiment reported a year ago. Now it is a pleasure to record that a carefully conducted experiment, carried out in the first half of the past year, has demonstrated conclusively that the species of tick in question (*Amblyomma hebræum* Koch) is an agent in the transmission of the disease. More recent work shows what would rationally be expected, that the attack of the tick is normally non-infective. A few only are needed to give the disease when these come from a diseased animal, and this is true even when the interval between the ticks leaving the diseased animal and gaining access to the susceptible one is of six or eight months' duration. When the disease becomes manifest, the ticks that conveyed it may have already left, which fact explains how it is that no ticks whatever are to be found on some affected animals. Other officers of the Government have found that the disease may be communicated by blood inoculation; but to ensure death virulent blood to the amount of three or more cubic centimeters is used—an amount scores of times in excess of what is drawn by the number of ticks necessary to carry the infection simply incidental to their bite. In a recent experiment five nymphal ticks (Bont) produced a fatal case. The ticks must infect through the skin; whilst blood inoculation, to be uniformly successful, must be intravenous; even ten to fifteen cubic centimeters of virulent blood injected

subcutaneously, Mr. Dixon has stated to the writer, is not certain to produce the disease in over three-fourths of the animals inoculated. Such facts as these appear to indicate that the disease is due to a micro-organism in the blood which is taken up by ticks in their feeding and in the Bont Tick at least then undergoes development in which it becomes immensely intensified in virulence; in other words, it appears that the tick is an intermediary host for the disease organism, not yet discovered, that causes the malady. It has not yet been shown that other species of ticks may not convey the infection, but investigation in this direction is being pursued. The main experiment conducted during the period reported upon will be discussed at length in the second part of this report, but it may be here stated that everything learned to date concerning the transmission of the disease is hopefully indicative that the complete withholding of *all* sheep and goats from a given piece of veld for a period which while still of uncertain length is short in terms of seasons will entirely remove the infection although ticks in abundance remain. The fact that sheep are again being profitably farmed on some stretches of previously infected veld in the vicinity of Grahamstown lends colour to the view; and to the writer there seems reason to hope that the many hundreds of square miles of territory in the south-east of the Colony now considered useless for small stock will again be lucrative for sheep farming and that thereby the valuation of the farms will gradually advance to what it was before heartwater become a factor with which the occupiers had to reckon. In some sections land is now considered worth only one-half of what it was formerly. Full realisation of this fascinating hope would doubtless mean drastic enforcement of harsh legislative enactments, and the years may be many before the time is ripe for such. The suggestion may be premature, but the sooner the possibility of ridding the country of the evil is broached, the earlier will the public affected come to appreciate the facts that are discovered and to interest themselves in the evidence for and against co-operative effort, thus smoothing the way for legislation. Certainly no harm will have resulted from having been optimistic

should some fact be hereafter brought out which renders attempted suppression of the disease in the manner intimated, temporary suspension of grazing small stock, appear an absurdity.

An experiment to determine through how many stages of existence capacity to infect persists in the Bont Tick after the acquirement of the infection from a diseased animal is in progress at the time of writing; also experiments to ascertain if certain common species of ticks other than the Bont may act as transmitters. In all the experiments kindly encouragement has been given by Dr. Hutcheon, the Colonial Veterinary Surgeon. He has had *post-mortem* examinations made of all the animals that have succumbed to authoritatively affirm the fact that death was due to heartwater, and has likewise rendered assistance in all the blood inoculations that have been required. Mr. L. J. Roberts, and several other Eastern Province farmers have rendered much appreciated service by collecting and forwarding engorged female ticks of various species from which larval ticks for the experiments have been reared.

Beneficial Insects.—While absent on leave in the United States, the writer was requested by the Department to make arrangements for the introduction of such enemies of scale and other insect pests at the Cape as he might consider desirable. Acting on these instructions several consignments of ladybirds were despatched from America to the Colony *via* England. In all, living material of seventeen species was sent between July and October; nine species were feeders on aphis and eight on one or more kinds of scale. The insects on receipt at the Cape were taken in charge by the Assistant Entomologist. Mr. Mally took great interest in the introductions from the first and has spared himself neither time nor trouble in the arduous task of properly caring for them. As was feared, despite his best endeavours, most of the species have been lost. However he has contrived to keep a number breeding and among these is the most valued species of all, *Cryptolœmus montrouzieri*. It is the species that is said to have proved of inestimable value when introduced into the Hawaiian Islands seven or eight years

ago (see *Agricultural Journal*, May 13th, 1897,) to subdue a mealy bug pest. Queensland is its native home. At the office it is now thriving nicely on mealy bugs and allied scale insects. Specimens in various stages have been liberated in a Constantia vineyard to feed on the mealy bug of the grape, and before long strong colonies will be started on the mealy bug of the pineapple at Bathurst in the eastern part of the Colony. Both of the mealy bugs mentioned threaten to become serious pests, and hence the introduction of the ladybird is timely. A generation of the ladybird in summer takes but six or seven weeks. Both beetle and larva attack the scale voraciously. The beetle is about the size of our common yellow species; it is black in colour with orange-yellow spots at the tip of the wing covers and on the prothorax.

Further details of the introductions will be given elsewhere in the report. For assistance in procuring the ladybirds in America, the writer is indebted to many friends, but especially to Professor Alexander Craw, the State Board of Horticulture Quarantine Officer and Entomologist of California, and Professor F. M. Webster, the Entomologist of the Ohio State Experiment Station. Professor Craw shared his office colonies of several species and spent several days assisting in the collection of others. Professor Webster went to considerable expense of time and trouble in collecting a seemingly valuable scale-feeder (*Pentilia misella*) in a distant part of his state, and assisted in the collection of other kinds. A supplementary sending of the species named has been received from him recently. In addition to procuring the species which were sent, arrangements were made in America for getting others, at the time not in season, through courtesy and exchange.

Efficient natural checks in the form of tiny wasp parasites occur in South Africa to keep the Black Scale (*Lecanium oleæ*) in complete suppression. This fact was the subject of comment in the writer's report for 1898 and thereby became known in California where the Black Scale is highly injurious over an immense area to orange, olive, and stone fruit trees as well as to many ornamental plants. Correspondence with Mr. Edward M. Ehrhorn, the Horticultural Commissioner for Santa Clara County, followed

and eventually led to a formal request from the United States Secretary for Agriculture to our Government for assistance in securing the establishment of the parasites in California. In compliance, sendings of parasitized scale were made from the office in May, September and October. The first lot was taken by the writer as far as New York; and from it after receipt in California were obtained numbers of what appears to be the principal of several parasites concerned, *Scutellista cyanea*. The efforts to breed the species so far seem to have been successful and in the last advice we were informed that a few colonies had been placed in orchards. The scale is said to have but one generation a year in California, whilst the parasite passed through a generation in six or seven summer weeks. It is planned to despatch another sending from the Cape in March and to include in it material of one or more of the supplementary species that attack the scale. It is still too early to forecast the future of these beneficial insects in California, but considering the similarity of climate between the Cape and there, the chances really seem good for their practically ridding the State of what is at present its worst scale pest. If establishment fails from the material already sent, other sendings will be made from time to time.

A sending of beneficial species of ladybirds native to the Cape, comprising several hundred specimens of three common species *Oenopia cinctella*, *Chilomenes lunata*, and *Adalia flavomaculata*, was made to Ascension in December in response to a formal request from the authorities of that island to our Government. Sufficient time to learn in what condition the insects arrived has not yet elapsed. They were packed in a tight box of odourless wood with bountiful provision for foothold and hiding and with absorbent paper enclosed to take up excess moisture; no food was enclosed but the box was placed in the cool chamber of the vessel.

The distribution of Vedalia to applicants complaining of outbreaks of Australian Bug (*Icerya purchasi*) on payment of the regulation fee of ten shillings is still continued, but fewer colonies were called for this year than in any other since distribution began; twenty-two sendings are

recorded. With each recurring season since its introduction into the Colony it has become more and more difficult to collect Vedalia when it is wanted, and several of the applications were filled from specimens forwarded from California by the writer. Near San Francisco the suppression of the Australian Bug by Vedalia is not nearly so thorough as about Capetown; and in California there is, consequently, little of the trouble experienced here in rearing or collecting the predatory insect.

Hydrocyanic Acid Fumigation.—No special effort to urge the fumigation of citrus orchards was made in 1900; but the sales of cyanide by the Department show that despite the troublous times, fruit growers in various sections of the Colony are continuing the treatment. The Assistant Entomologist supervised the starting of a £75 fumigating outfit at Montagu in September. Owing to the war and a shortage of cotton the price of canvas is very high; when it falls to its old level more will be done by the office in advertising and otherwise stimulating the application of the remedy to scale-infested orchards.

The bed bug (*Acanthia lectularia*) in many of our gaols has long been a source of severe annoyance to prisoners and their guards, strenuous efforts to suppress it notwithstanding; and at the request of the Colonial Office the utility of cyanide fumigation to effect a riddance was demonstrated at the Worcester prison under the personal supervision of the Entomologist. The gaol building there is an old one and although the cells appeared clean and well kept the deep crevices in the ceilings and walls were terribly infested with vermin. One pound of cyanide to twelve hundred cubic feet of space was used and the cells kept closed for two hours or more. Nearly a year has elapsed to date since the fumigation, and on enquiry it is learned that time has proved the operation a complete success. The gaols at Tokai and Kimberley are soon to be treated and it is expected to use about one hundred pounds of cyanide at each. All of the badly infested gaols would have been fumigated ere this, it is understood, were it not that the extremely poisonous nature of cyanide and the consequent risk to human life renders it

inadvisable until the services of an intelligent and competent operator for the duty is secured. This office has performed its part in demonstrating the efficacy of the operations and that they may be safely conducted under competent supervision.

Minor Investigations.—Studies to elucidate the habits and metamorphoses of our more important tick pests have been kept up throughout the year, and many observations of scientific interest and practical value have been made, which will in due time be put in print. The Assistant Entomologist has spent some time in field experiments with insecticides directed against a number of pests, notably the "risper" (*Heliothis armiger*) of Western Province orchards, the Vine Mealy Bug (*Dactylopius sp.*), the Diamond Back Moth (*Plutella cruciferarum*) of the cabbage, and the Lucerne Caterpillar (*Colias electra*).

A series of experiments, yet incomplete, to determine the value of substances recommended for destroying or driving away weevils and other insects injurious to stored grain has also had the attention of the office. Carbon bisulphide for the purpose is a well known and apparently widely used remedy in America and Canada, but unfortunately it is a chemical not easy to obtain in the Colony away from the principal ports, and it is even there expensive. Napthalin as a deterrent and hydrocyanic acid as a destroyer, have recently had the recommendations of entomologists of good standing, but our experiments thus far indicate that they are of almost no practical value.

Examination of Plant and Fruit Imports.—All packages containing fruit, bulbs, plants, &c., received from abroad at the General Post Office are courteously sent to this office by the postal authorities for inspection under the Import Regulations (Proclamation 107, 1896). One hundred and thirteen packages were opened and examined during 1900, but no finds worth record here were made.

Early in the year arrangements were made with the Department to permit this office to examine the consignments of trees and plants coming through the port of Cape Town, leaving other produce affected by the regulations, as fruit, potatoes and onions, to be examined as before by

the Customs official who is paid for that duty. Since then the regular examiner has notified the office when plants and trees arrived, and it has been one of the Assistant Entomologist's duties to go to the Docks and carefully inspect the consignments for insect pests and indications of disease. Finds of injurious insects have been rather numerous, and a few deserve mention. In August two large consignments of assorted fruit trees from Sydney, New South Wales, together valued at about £500 by the importer, were found to bring with them the San Jose, or Pernicious Scale (*Aspidiotus perniciosus*), and the Black Peach-Aphis (*Aphis persicæ-niger*). Both lots were confiscated, and every tree and all the cases and packing material burned on the beach. Many of the trees were very badly infested with one or other of the two insects. The importation had been made to fill orders already taken from fruit growers in various parts of the south-western districts, and if it had been allowed to come through unrestricted would undoubtedly have sufficed to widely and firmly establish two destructive pests. The San Jose Scale is the notorious insect which has made such a commotion among horticulturists in the United States of recent years, and has led to Canada and several European countries legislating against American nursery stock. The Peach Aphis is becoming a well known pest in American nurseries and young orchards. In the New South Wales Report on Agriculture for 1899 occurs this statement in treating of it, which shows plainly it is a pest that deserves our regard: "This is, without doubt, the most serious pest that the growers of summer fruit have to contend with, and, as it has spread all over the colonies, and winters both upon the roots and lower branches of the trees, it is very difficult to deal with. Constant spraying until the fruit is set seems to be the only check."

Later in the year several ash trees from England in a consignment to a colonial nurseryman were found badly infested with the Oyster Shell Bark Louse (*Mytilaspis pomorum*). The trees were promptly burned. This scale is the so called "blight" that threatened the Tasmanian apple orchards some years ago. It is well known in Europe and America and affects a wide variety of plant

growth. Other consignments of trees were found infested with scales of less feared species, and were permitted to pass after thorough fumigation with hydrocyanic acid gas, and removal of all the scales that could be found. Among the scales was *Diaspis rosæ* on rose plants from New York. Several consignments of potatoes were condemned and destroyed because infested with the Tuber Moth (*Lita solanella*); and, as usual, the regular examining officer required the fumigation of all scale-infested fruit.

Correspondence and Publications.—The correspondence of the office shows a falling off of nearly one-third compared with that of the previous year; but the distraction from ordinary affairs caused by the military operations in the Colony is undoubtedly responsible for the diminution. The publications have been fewer than usual, owing partly to the writer's absence from the Colony, and partly to the close application given the tick-heartwater experimental work. The contributions to the *Agricultural Journal* have been as follows:—

TITLE.	Illustrations.	Form.	Issue.	Pages.
Fruit Fly Notes	..	Letter.	Jan. 4	Vol. xvi. 43-5
Two Pineapple Pests	Two; one original	Article.	Jan. 18	94-102
Arsenic for Locusts	..	Letter.	M'ch 29	449-450
Cockroach Pest..	..	,,	,,	450
Tick-Heartwater Experiment ..	Three; original	Article.	May 24	682-7
The Fruit Moth	..	Notes.	July 5	Vol.xvii. 41-4
Smudge for Fruit Moth	..	Letter.	Aug. 16	238

Acknowledgments.—In concluding the general statement of the year's work, it is a pleasant duty for the writer to record his indebtedness to the South African Museum authorities for free access to the insect collections. The entomologist of the Museum, Mr. L. Peringuey, has been uniformly attentive to our wants, and has never

spared himself trouble in determining specimens which we have submitted to him for identification. It is also a pleasure to state that the United States Entomologist, Dr. L. O. Howard, has constantly maintained an active interest in the work of the office from the time of its establishment in 1895, and is ever ready to assist in the determination of insect material by comparing specimens with those in the immense collections deposited under his charge at Washington. To him and his staff of assistants we owe much.

Finally, an expression of thanks and appreciation is due Mr. C. W. Mally, the Assistant Entomologist, who has just completed his first year's connection with the Department. Prepared for his labours here by a university training and eight years of practical work under two leading American entomologists, and a liking for natural history born in the man, he has abundantly testified to the literalness of the flattering testimonials he submitted prior to his engagement by continuous hard and enthusiastic application to the duties assigned to him. For six months of the year he had full charge of the work.

PART II.

TICK-HEARTWATER EXPERIMENT.

Notes on an experiment conducted in the latter part of 1899 with the view of ascertaining if any relation existed between tick parasites and the heartwater disease of sheep and goats were published in my annual report for last year. The results of that experiment indicated, though not in a satisfying degree, that Bont ticks (*Amblyomma hebræum* Koch) fed in one stage on heartwater diseased animals may in their following feeding stage transmit the disease to susceptible animals; and, secondly, that Red ticks (*Rhipicephalus evertsi* Neumann) under similar circumstances do not transmit the disease. In this experiment two goats only were exposed to the presumed possible sources of infection,—one being exposed to the attack of adult Bont ticks nourished in the nymphal stage on diseased animals, and the other to adult Red ticks nourished in the nymphal stage on the same diseased animals. The first goat developed a fever after a few weeks, which if not the fever of heartwater at least resembled the fever of that disease, whilst the second goat gave no noticeable reaction.

The 1899 experiment was followed in the first half of the year being reviewed in the present report by an experiment on exactly the same lines but conducted more systematically and with a greater number of animals. A preliminary report on the work while it was still in progress was published in the *Agricultural Journal* for May 24th.

Plan of the Experiment.—To clearly understand the experiment, it is necessary to bear in mind that the ticks concerned, the Red Tick and the Bont Tick, have three distinct stages, during each of which they take blood from an animal. In the first or larval stage the ticks are mere specks and naturally crawl on to the animal from grass tops or other vegetation, The Bont larvæ attach themselves almost anywhere, whilst the Red larvæ generally

wander about until they get deep into the ears. In a few days both kinds have stretched their skins to the utmost with the blood imbibed, and then must perforce cease feeding. The larval Bont lets go its hold and drops. The larval Red retains it hold. After a varying interval of quiet, which is far longer in the case of the Bont than in the case of the Red, both shed their larval skins and become voracious again. They have now entered the second or nymphal stage. The Red nymph settles down at once near its old skin in the ear; the Bont nymph proceeds to find a host. In due course the two kinds of ticks become engorged again and then *both* drop off, and after resting awhile shed their skins as before, thus entering the third or adult stage. The Red adult seeks the anal regions by preference; and the Bont adult, the belly, the udder and genitals. The third and last feed taken, the females of both kinds drop off, secrete themselves, and in their hiding places lay eggs for the succeeding generation.

The plan of the experiment was to get large numbers of both kinds of ticks engorged on animals infected with heartwater, and when these ticks dropped naturally, to collect them, care for them until after they moulted, and then to liberate them on healthy animals.

Infection of the Ticks.—Bont and Red larval ticks for the experiment were obtained by the incubation of eggs at the office. The mother Bont ticks were from cattle in the Fort Beaufort district and the mother Reds from one of the goats used in the previous experiment. These larval ticks were taken to Mr. Llewellyn J. Roberts' farm, Cottesbrook, in the Fort Beaufort district, in February for the purpose of carrying them through their first feeding stages on heartwater diseased animals. Cottesbrook is a farm which when stocked with sheep some years ago became badly affected with the malady and hence was a site which I was certain would be favourable for the initial part of the experiment.

Four old, angora, ewe goats to serve as hosts for the ticks had by previous arrangement been procured by Veterinary Surgeon R. W. Dixon and infected with heartwater by intravenous inoculation of blood from a diseased

animal. These goats were numbered 1, 2, 3 and 4. No. 1 had been given 20 c.c. of diseased blood and the others each 10 c.c. There being a slight doubt in regard to the virulence of the blood used by Mr. Dixon, the animal he drew from not having been as ill from its fever as it might have been, an opportunity was taken to re-inoculate two of the animals, Nos. 2 and 3, with blood drawn from a sheep which chanced to be dying from the malady on the next farm. Mr. Roberts conducted the operation and injected 10 c.c. into the jugular of each. The first inoculations were made February 23rd, the second, February 28th.

All four goats reacted to the inoculating, the temperature rising abnormally in twelve to fourteen days. Ordinarily the fever of heartwater begins to be manifest about the ninth day from intravenous inoculation with virulent blood. Goats 1 and 4 passed through several days of fever without manifesting their illness in their appearance or by lack of appetite. The temperature of 1 reached the maximum, 105·1°, on the seventeenth day, and that of 4 the maximum, 107°, on the fourteenth day. Both these goats were later turned out on heartwater veld. No. 4 died some months after from causes not determined; 1 is still alive and perfectly healthy. Goat 2 became feverish on the twelfth day, evidenced severe illness by its hair, dejected appearance and lack of appetite on the day following, and on the next day succumbed very suddenly. The maximum of its temperature was 106·1°. An examination of the organs showed that its death was unmistakably due to heartwater. Goat 3 became ill on the thirteenth day and until the eighteenth seemed in danger of dying at any moment; she then rallied, but died from exhaustion the following week when turned out on to the veld. During all but the first four days the animals were confined in a stable and fed on the foliage of veld bushes. Owing to its stone walls, a room overhead, good ventilation, and the absence of sun, the stable was cool all of the time,—which fact doubtless had its effect on the temperature of the animals.

All four goats were infected with larvæ of the Bont, and goats 1 and 3 with larvæ of the Red. To ensure

having some of the ticks engorging themselves during the fever period, the larvæ were not all applied at once but numbers put on every other day.

Recovery of the Ticks.—The Red ticks, when they dropped as engorged nymphs which occurred in about two weeks from the date of their application, were caught in cloth caps tied over the ears. The caps were removed and examined four times a day. The Bonts, as engorged larvæ, began to drop in about four days and were caught in cloths suspended beneath each animal, and held in place by tapes tied over its back. The cloths were examined hourly, when the ticks were dropping, from early morning until late at night. The first catch cloths used, or "pants" as we graphically term them, were crude affairs, with hemmed openings for the insertion of the legs. In later experiments, under way at the time of writing, strongly made garments, which enclose the animal, legs and all, from neck to tail, are used, and are more satisfactory; when they are well fitted and properly tied there is no trouble from the passing of the fæces or urine, and practically all the ticks are caught uninjured.

The animals were fastened in sets of stanchions while the ticks were being fed and recovered, and thus were prevented from nibbling the cloths and tapes. The stanchions were fashioned much like those used for holding milch cows to their stalls in countries where cattle are stabled. The neck of the animal is held between two uprights which are far enough apart not to irritate the skin of the neck, but too close together to permit the head to be withdrawn. The goats could lie down and stand erect without any discomfort, and, after the first day so took the neck confinement to be in the ordinary course of affairs that they evidenced an anxiety to get back to the stanchions whenever released.

According to whether Bont or Red, the animal on which fed, and the time of dropping, the ticks recovered from the goats were classed as follows:—A, Reds from goat 1, and B, Reds from 3, during the fever; C, Bonts from 1, and D, Bonts from 3, during the same period; E, Bonts from 3 during first two days after fever; F, Bonts from 4 during

fever; and G, Bonts from 2 taken just after this animal died.

Tick Infection of Susceptible Goats.—The scene of the experiment was transferred to Capetown after the twentieth day. The various lots of ticks were placed in an incubator heated to 85°—92° F., and retained there until they moulted, and were thus made ready to feed again, the Bonts as nymphs, and the Reds as adults. They were then carefully separated from their cast skins, and placed in new clean boxes.

Cross-bred young angora ewe goats for the continuance of the experiment were procured from Stellenbosch, a district far removed from the heartwater section of the Colony; and as the animals were reared on the farms from which they came, no doubt was felt on their being susceptible to the disease. An old shed in the heart of Capetown was fitted up for the reception of the goats. Stanchions were erected at each end, and one end reserved for Red Tick infections, and the other end for Bont Tick infections. The shed was commodious, and fully thirty-five feet of space separated the two sets of stanchions. Eight goats, numbered on the horn from I to VIII, were brought into the shed at first, and two others, numbered IX and X, about a fortnight later. I to IV were put at the Red Tick end, and infected with that species, I and II with Lot A, and III and IV with Lot B, all dating from April 6th. Goats V to X were kept at the other end, and infected with the Bont Tick, V and VI with Lot C on April 6th, VII with Lot D on April 7th, VIII with E on the 10th, IX with F on the 19th, and X with G on the 22nd. The liberations were all made in cloths such as have been mentioned. Most of the ticks attached themselves within twelve hours. The Reds showed a disposition to roam, and doubtless some specimens got on to another goat than the one for which they were particularly intended. The Bonts, too, wandered somewhat, but much less than the Reds, and it is doubted that any went farther than to the next animal in line. It is possible, but not probable, that Reds crossed the shed to the Bont end, and Bonts to the Red end; if any such migration took place it escaped our detection, and we were on the watch.

All due precautions were taken to eliminate possible sources of infection other than the ticks. Nothing other than my person and the ticks that had been in contact with diseased goats was allowed to come into the shed. The clothes that I wore when working at Cottesbrook were left there, and hence it was unlikely that I brought any infection. The ticks had shed their skins, mouth parts and legs included, since having come from the diseased animals, and externally, were seemingly incapable of imparting disease. Oat forage and bran purchased locally were used as food. The previous use of the shed was as a store place for builders' materials.

The shed was not an ideal place for the conduct of the experiment, because of its variable temperature. It is a corrugated iron lean-to against a fence, loosely constructed, and without windows, and exposed the whole day to the full force of the sun's heat. The temperature readings of goats I to XI are not, therefore, directly comparable with the temperature readings of goats 1 to 4, the latter, as has been stated, having been kept in a cool stable.

Results of Bont Tick Infestation.—About seventy-five specimens of the Bont Tick attached to V goat; two hundred to VI; one hundred and fifty to VII; and one hundred and seventy-five each to VIII and IX. Lot G ticks applied to X consisted of twelve specimens only, and of these ten attached. The Bont Tick nymph is a tiny creature, small in comparison with the adult Red Tick, and even two hundred specimens seemed few when seen on the animal until engorgement was nearly completed. Nearly half of the attachments were about the feet; the remainder were scattered over the body, but chiefly along the median line of the ventral surface, and under the thighs.

Effects from the attack of the ticks became distinctly evident after an interval of eleven to fourteen days from the application of the specimens. Each goat in its turn was made ill, and showed its illness, not only by its rise of temperature, but by failing to partake of proffered food and drink, and by its dejected appearance and assumed positions. Number V gradually regained its normal appetite after a fever of several days' duration, in which its temperature rose to 107°. VI survived an attack in which

for a few hours its temperature registered above 108°. VII went through the course of high fever, but succumbed on the twenty-second day. VIII behaved similarly, dying on her twenty-first. IX had a short and distinct fever, but was not prostrated as were the other animals. X was made exceedingly ill, had a long fever, and never fully recovered. Dr Hutcheon, the Colonial Veterinary Surgeon, viewed the animals several times during their illness. His assistant, Dr. W. Robertson, conducted the post-mortem examinations on the two that succumbed, and attributed death in both cases to typical heartwater. It should be noted that the ticks responsible for transmitting the disease had all left the animals before these were taken ill.

At my request Dr. Robertson drew blood from VII, VIII, and X as their fevers began to abate. 10cc. from VII was injected into the jugular of I on April 26th, and on May 6th this animal died of heartwater. 10cc. from VIII was put into III, and this animal died from the disease May 8th. The blood from X was used to infect a small sheep, but unfortunately this animal died from other causes before there was time for heartwater fever.

It is worth noticing that the intensity of the fever in the various cases produced by the ticks appeared to vary with the intensity of the fevers in the animals on which the infecting ticks had been fed. The ticks from 1, an animal which was not thrown off of its feed by its illness, produced severe but not fatal cases (V and VI); those from 3, which was exceedingly ill, produced fatal cases (VII and VIII); those from 4, an animal not so ill as 1, although it showed a higher temperature, produced a rather mild case (IX); whilst those from 2, which died, though only ten in number, produced a long and very severe case (X). These apparent correlations may, of course, be mere coincidences.

Results of Red Tick Infestation.—About one hundred and twenty-five specimens of the Red Tick attached to goat I, one hundred and fifty to II, one hundred to III, and sixty to IV. The sexes were present in approximately even numbers. This species of tick is remarkably partial in

the adult stage to the hairless region about the anus and vagina and all of the specimens employed there located themselves. Owing to the size of the ticks and their occurrence over so limited an area the infestation seemed extremely heavy, especially as the females became engorged; and, indeed, infestation by this kind of tick to the same degree on the veld is improbable. Although fewer specimens attached to III and IV than to I and II, the former goats were presumably exposed to as much danger of infection since the specimens they received came from a more badly diseased animal.

The experiment was continued until the 5th of June and the temperatures taken twice daily, morning and evening, during the period. Two of the animals, I and III, as has already been explained, were inoculated with virulent blood on April 26th, and hence the experiment closes for them with this date. No symptoms of disease suggestive of heartwater other than abnormal temperatures occurred in any of the goats.

For purposes of study and comparison the temperature records of all the goats confined in the shed during the period of observation are submitted—(See page 61) In addition to the records of the Bont Tick and Red Tick goats, the records of two goats not heretofore mentioned are given, in one case dating from May 2nd and in the other from May 12th. One of the animals, XI, was not molested with ticks; Blue Tick larvæ, indeed, were applied to her, but none became attached. The other, XII, served as a host for a few nymphal tortoise ticks (*Amblyomma devium*); these ticks as larvæ had fed on a quail, and there is no reason to suppose them to have been pathogenic. Unfortunately this goat aborted on the eighth day temperatures were taken, yet except for a few days immediately subsequent to this accident, the temperatures may be safely accepted as normal to an animal in health under the circumstances of the season and confinement.

Abnormally high temperatures rule for goats I to VI throughout. In the case of the Bont Tick infected goats no evidence of disease was shown by the temperature (or otherwise) before the eleventh day, and we may assume that such would have been the case in I and IV. Prior

to the eleventh day, the temperatures of the two lots of goats should show much uniformity; but a comparison shows the temperatures of the Red Tick goats to have been relatively higher. The difference is most marked in II and IV, the average morning temperatures of which for the period are respectively 103·5° and 103·4°. Heartwater can hardly be held to account for these high temperatures. Suspiciously high temperatures rule in I, II and III between the twelfth and fifteenth days, April 18th to 21st, the period when heartwater fever would be expected to occur from tick infection as shown by the Bont Tick infected goats. The temperatures of IV, although constantly much above the normal at the same time are not comparatively high. But the days in question were oppressively hot, with hot nights, and this fact in connection with the circumstance that the animals were confined in a close shed doubtless had considerable effect on the body heat, and this effect we may rationally assume to have varied in degree with the different animals. It will be observed that during the same period the temperature of VIII was also very high and that it fell before the true fever rise came on some days later. All in all, therefore, it is unsafe to conclude that the high temperatures of I to IV for these days was due to the disease. From May 12th to the close the records of II and IV may be compared with those of XI and XII; and it then becomes more evident that the temperatures of both are erratic and often abnormally high. XII, be it remembered was practically free from suspicion of infection, and XI was absolutely so. Therefore it seems clear that the Red Tick animals then surviving, II and IV, and probably I and III as well, had been affected in temperature by some factor present in them but not present in XI and XII. The data of the experiment is insufficient to determine whether or not this factor was heartwater infection. However, Mr. R. W. Dixon, of the Colonial Veterinary Staff, who has been paying close attention to heartwater for several years, with the object of discovering a safe means of immunising animals, has studied the records by request. He does not think the high temperatures can be wholly attributed to the heated atmosphere of the shed, and

suggests that the goats were slightly infected with heartwater by the ticks. In his experimental work, he said, he had somewhat similar temperature records from animals which under his manipulation were suffering from very mild heartwater. These mild attacks, he further said, gave the animals little or no protection from infection later on.

It will be noticed that fever developed in III on the ninth day after inoculation with virulent blood from the Bont Tick infected animal, and that death came on while the fever was still high. Such behaviour is typical of a case of heartwater from intravenous inoculation with a lethal amount of virulent blood; and, as already stated, the *post-mortem* revealed heartwater. Goat I, from a similar inoculation gave a somewhat different reaction. Fever set in on the third day after the inoculation, ran a course and abated, and then rose and culminated in death on the tenth day. At the time it was feared that the Red Tick infection may have been a factor in causing the first rise of temperature, but recently it has been learned from Mr. Dixon that such a course of fever following close on inoculation has not been infrequent in animals he has infected. Therefore, the infection of both I and III affirms simply (1) that the animals were susceptible to the disease, and therefore would have taken it from the Red Ticks were these able to communicate it, and (2) that the disease produced by the Bont Ticks was certainly heartwater.

Conclusion.—The experiment conclusively demonstrates that a very limited infestation by nymphal Bont Ticks which fed in their larval condition on a heartwater diseased animal will produce the disease in a severe form in susceptible animals. And (2) that even a gross infestation by adult Red Ticks which fed in their earlier stages on a heartwater diseased animal will not produce severe cases of the disease in susceptible animals. The experiment indicates but does not prove that the Red Tick may by gross infestation by specimens from a diseased animal transmit a very mild and unimportant form of the malady.

Incidentally, the experiment affirms to some degree the findings of the Veterinary Department to the effect that the disease is not contagious. The animals employed

in the latter half of the experiment were confined in the one shed, were fed the same kind of food, were watered from the same buckets, were handled by the same men in the same clothes, and their temperatures taken twice or more daily with the same thermometers; yet all the positive cases of the disease appeared only after a definite time from the application of infective ticks and the two animals which received no suspected ticks gave no indication of disease whatever.

It has not been shown that the larval ticks produced from mothers which engorged on diseased animals may communicate the disease; that is, that the disease is communicable through the egg stage. But the experiment of a year ago, mentioned in the opening paragraph, may now be accepted as showing that the disease is transmissible from nymph to adult.

"NATURAL ENEMY" ENQUIRIES, AND LADY-BIRD INTRODUCTIONS.

Explanatory.--At the annual fruit growers' congress held at Stellenbosch in May last, it was resolved: "That the Government be asked to immediately instruct Mr. Lounsbury, who is now on his way to America, to make such enquiries as he may deem to be desirable with the view of discovering such natural enemies of scale and other insects as may assist in ridding the Colony of these pests; and to arrange for the importation of such enemies in sufficient numbers to ensure a hope of the eventual extermination of scale, &c., through their agency. Further that Mr. Lounsbury be asked to make an enquiry into the Anaheim disease among vines." The Secretary for Agriculture favourably considered the resolution and it was accordingly transmitted to me with the request that I give the matter my attention. As I was due in the Colony again in less than four and a half months from the time the correspondence reached me, it was utterly impossible to accomplish a tithe of what might be done in the line of the request; but I knew the fruit growers

meant that I should give special attention to the Red Scale question whilst whatever else might be done at the same time would be acceptable. To go fully into details relative to the numerous enquiries made would avail nothing, and I shall now simply report concerning the Red Scale and the beneficial insects which were obtained and forwarded. The subject of Anaheim disease of the grape may be dismissed with the mention that an account of it has been submitted to the Department and is published in the *Agricultural Journal* for January 17th, 1901.

Red Scale.—The Red Scale (*Aspidiotus aurantii*) is *the* scale in Cape Colony. It occurs practically everywhere in the country where oranges are grown for sale though there still remain occasional farms which by good fortune or great care, or both, have been kept clear on it. The extent of the damage done by it varies in different districts and localities, but it is deserving of the term "pest" wherever it is found with us and, in general, its presence spells little or no fruit and slow dying back of the branches to heavy wood or even to the ground when protection to the tree is not given by insecticides. Five or six species of our ladybirds attack it, and at least one hymenopterous parasite has been bred from it in large numbers; two or three fungus diseases, too, have been observed to affect it, but the combined influence of all the natural enemies is slight What the colonial fruit growers desire is that *efficient* enemies be found and introduced; and it was thought that I might get such in America or gain information as to where they might be found.

For the purposes of the quest, I consulted many of the leading American entomologists and visited the principal sections of California where the scale occurs and there discussed the matter with horticultural officials. These enquiries and observations led to the conclusion that no natural enemies of scale insects are known in America that would be likely to prove of much value against the Red Scale if introduced into the Colony; and further that no one is yet aware of the proper place in which to search for the much desired enemies. In Southern California,

where the Red Scale is an introduced orchard pest, several indigenous ladybirds, and a number of hymenopterous parasites (Insect Life, VI, p. 227), have been observed to attack it but the combined effect of these seems of no more value than the effect of our own natural enemies. Nearly ten years ago, *Orcus australasiæ* and *Orcus chalybeus*, two Australian ladybirds of prominence, were introduced purposely for the scale, but although the latter gave some promise at first their assistance now is hardly appreciable. Just as in this country resort to fumigating or spraying is still necessary to get profitable returns from infested trees.

Among those with whom I discussed the question, opinions were much divided as to whether or not such blessings as efficient natural enemies for the scale were anywhere to be found. No hope at all was obtained, for instance, from Dr. L. O. Howard, the Entomologist of the the United States Department of Agriculture, nor from his chief assistant, Mr. C. L. Marlatt, the former the highest authority on the hymenopterous parasites of scale insects and the latter a close student of scale insects themselves. They would not actually say they thought there was no chance, but let it be inferred that there appeared so little chance that it were much better to expend one's energies in developing and encouraging artificial remedies,—the use of which they considered would probably still be profitable if not absolutely necessary in the event of the best possible parasites they could imagine being found. Mr. Marlatt further thought that in time the destructiveness of the scale would greatly decrease, not through the establishment of new natural enemies or a gradual increase in the old ones, but through the workings of much more obscure influences. On the other hand the Californians were quite hopeful in their views. The Entomologist of the State Board of Horticulture, Professor Alexander Craw, was quite confident that proper search will reveal some enemy or other which shall once and forever settle the Red Scale problem in his State. His Board seemed similarly sanguine, and even at the time had an agent travelling in oriental countries with the special object of securing enemies of this and other scales which remain destructive in California. This agent, Mr.

George Compere, was at the time of my visit in Australia, from whence he proposed to visit China. He had reported that the conditions in Australia as regards the Red Scale were practically as bad as those in California. The funds at the disposal of the Board for the investigations were nearly exhausted but I was informed that more would be requested from the State government to continue the search in other fields should those now being searched reveal nothing of promise. The Californians do not claim the profound knowledge of the interrelations of life possessed by the Washington officials; but have faith that devastating infestation by an insect is unnatural and almost solely due to the temporary absence of natural enemies. And they are encouraged in their simple view by their observation that a number of once important scale pests of their State have one by one been suppressed through natural enemies accidentally or purposely introduced. As indicative that the Red Scale cannot be an exception, they cite the case of the Yellow Scale (*Aspidiotus citrinus*) which is so closely related to the Red that the two are often confused and are even yet generally considered by scientists as varieties of one species. The Yellow Scale has practically disappeared wherever it occurred through a hymenopterous parasite disseminated by Professor Craw and others for the purpose of checking it. The parasite to which credit is given is *Aspidiotophagus citrinus*. To see for myself that this scale was now suppressed I visited and examined orchards in San Gabriel and Redlands which were said to be formerly the worst infested in the respective districts; and I had considerable difficulty in finding any of the scale at all.

The most likely place to find natural enemies to battle with an introduced insect is considered to be in its native habitat. The native habitat of the Red Scale is unknown. Commerce had already distributed it very widely before it became known to science by name and there was no tracing its origin. It was conjectured by its describer (W. M. Maskell, 1878) that it came from southern Europe; and Dr. Howard and some others competent to offer an opinion are inclined to think the surmise correct. Occasionally there is a little of the scale on citrus fruits received at the

Cape from southern Europe and as there is generally none and seldom much, it seems possible that the scale may occur in Italy and Spain, from whence the fruit comes, but to be there kept in check by natural agencies. Scales of other sorts are often abundant on the fruit so artificial remedies are not likely to be responsible for the scarcity of the Red. The scale has been recorded to occur in southern Europe for over twenty years which shows that its apparent scarcity is not likely to be due to its not having had time to spread. At my request Dr. Howard looked over his records, and specimens of parasites bred from the Red Scale in Europe, however, and from there as elsewhere found no record or specimen of any species of which there is the least likelihood of its being consequential if introduced to the Cape. Therefore while there reasonably seems a chance that efficient natural enemies occur in Europe, there is no record of their being there and no evidence beyond the mere fact that the scale is not known by us to be there injurious whereas it is injurious wherever else we know it in similar climate. The Californians have always believed that the scale originated in Australia, as they are confident that it reached their State from there; but now that they have had that land searched in vain for natural enemies, they may turn their attention to the south of Europe. We hope so.

In Natal the Red Scale suffers from the attacks of a parasitic fungus which I believe to be identical with *Sphærostilbe coccophila* found in Florida on the San Jose Scale. The fungus has long been known in Europe as occurring on dead scale insects but investigations in Florida proved that it was a specific cause of death. The same fungus is said to attack the Red Scale in Queensland; and very recently in response to an enquiry the Ceylon Entomologist, Mr. E. E. Green, has written me that it or a closely allied form is an important check on the same scale there. During the last year the Natal Entomologist, Mr. Claude Fuller, favoured us with several sendings of orange twigs encrusted with scale affected by the disease and these twigs were tied to infested trees at Newlands with the object of infecting the scale thereon, but in no instance was the disease found to spread. It is

surmised that the climate at the Cape is unfavourable for the propagation of the disease, the summers being too dry and the winters not warm enough. Since making the trials, the fungus has been discovered elsewhere in the suburbs on a lemon tree which is indicative that it occurs at the Cape already. That it occurs in the east of the Colony was learned three years ago; a species of native scale was found much diseased by it in the bush near Port Alfred in the Bathurst District, but no trace of it was seen in the Bathurst orange orchards. Some more trials at propagating it in the orchard will be made but success is not anticipated.

Introduction of Aphis-feeding Ladybirds.—Aphides or plant lice are frequently complained of by our farmers. One species frequently does damage to cabbage, rape, and allied plants; a second species is often complained of in grain crops; a third in the melons; whilst others as the Woolly Aphis of the apple and the Black Aphis of orange and lemon trees are equally well known. Ladybirds, syrphus flies, aphis lions, and wasp parasites, of one kind or another, prey on all of the different species and some of them at least have fungus diseases as well to contend against. Natural checks of other kinds are still more potent in offsetting their marvellous reproductive powers; thus myriads perish on the citrus trees with the hardening of the young wood, and violent rains dash other myriads to the ground never to regain their food plants. The most conspicuous as well as the most important in many cases, of the insect enemies are the ladybirds. But no species of ladybird can increase in numbers to compare with an aphis. Few ladybirds have more than three or four generations a year in even warm climates whilst aphides are often grandparents before their first month of existence is finished. Thus it comes about that when conditions favour the increase of an aphis and it has even a short start of a ladybird enemy, the plant infested may be severely injured before the aphis is suppressed. To cite a common example: A species of aphis (*Nectarophora pisi*) sometimes finds our sweet pea plants early in the spring, and, say, for a week has undisturbed possession. Then the infestation is discovered by a wandering ladybird on the search

for just such an occurrence, and who at once proceeds to avail herself of it, feeding voraciously herself and laying eggs that her progeny may share the feast. The eggs hatch in about a week, and then a swarm of hungry larvæ slay the helpless lice right and left. Doing their best, however, and aided by other ladybirds that have been attracted to the scene, they cannot even dispose of the increase. In a few weeks the larvæ turn to pupæ and then to adults. A second generation of larvæ is shortly produced, and then the aphis is quickly overcome. Sometimes, of course, the aphis is overcome more speedily and sometimes less so; from the beginning, almost, there was no doubt as to ultimate suppression. In some gardens the aphis may be kept in close check from the beginning and never be able to injure the plants; in others near by the plants may be irreparably damaged before relief is afforded.

The ladybird larvæ wander about when their food supply is exhausted, but not having wings, they do not get very far; some eventually find food and live to propagate, but the vast majority die of starvation or fall victims to their cannibalistic brothers or to other foes. For weeks at a time there may be practically no aphis of any kind in a locality, and then the ladybirds become fewer and fewer, so that when aphides begin to appear again, there are very few ladybirds about to find them. Other enemies of the aphis-kind suffer similarly. These facts render it somewhat doubtful that the injuries to plants from aphides in general could be much lessened by importing new species of ladybirds since the new-comers would suffer from the same disabilities as our native kinds. Still, it is possible that the conditions might be somewhat bettered if the imported species propagated more rapidly than the natives, if they started to feed a few days earlier in the spring, or kept at work through our mild winters when there was food; likewise if they had a wider range of foods that would enable a greater proportion of them to live through their famine periods, or if they possessed greater vitality that would assist in carrying them through. As regards one aphis in particular, the Woolly Aphis of the apple, it really does seem

a ladybird might be found that likes it better

than our native species; but it is a species that, as far as I have been able to learn, is not much eaten by any kind of ladybird when other food is available. Unfortunately, very little is recorded of the habits and peculiarities of the various kinds of ladybirds that would assist us in making a choice of species for attempted colonization at the Cape, and therefore a successful introduction is a matter of chance.

While in America, the opportunity was taken to secure specimens of kinds there common, in the hope that one or more of them would prove a benefit to us. Unfortunately I was not there at the season most favourable for collecting, and therefore had difficulty in getting together sufficient numbers to make sendings; a few weeks earlier I could have easily obtained a hundred specimens where I got one. From what has been said, it is clear that to make certain of the establishment of any species dependent on aphis, considerable numbers are required, thus to offset the fluctuations in the food supply and the dispersal of the specimens in search for food. But not being able to find considerable numbers, what was found was sent, with the hope that some of the kinds at least would breed in confinement until there were sufficient for liberating out-of-doors. One sending was despatched, July 23rd, *via* London, and arrived at Capetown August 21st. As did all the sendings to be mentioned, it travelled in the cool chamber from New York to Southampton and from Southampton to Capetown. The specimens were all packed in a wooden box, about six inches by six inches by ten inches inside measurement; they were given foothold and a chance to hide away from one another by making a series of compartments in the box and packing these loosely with paper, and further by securing wide strips of thin board just far enough away from the sides to give the beetles a chance to crawl in between. At each end of the box for ventilation was provided a gauze covered aperture the size of a florin. When opened at Capetown, specimens as follows were found in the box:—

Megilla maculata, 40 alive (about), 194 dead.
Coccinella 9-*notata*, 300 alive (about), 38 dead.
Hippodamia parenthesis, 30 dead, 45 alive.

Hippodamia 13-*punctata*, 22 dead, 55 alive.
Hippodamia glacialis, 1 dead, 35 alive.
Coccinella transversoguttata, 9 dead, 18 alive.
Coccinella sanguinea, 24 dead, 4 alive.
Adalia bipunctata, 14 dead, 6 alive.
Unrecognized species, 10 dead, 10 alive.

Doubtless many of the specimens were already old when they started on the journey, and would have soon died under any circumstances; hence the condition of the insects on their arrival, as a whole, was very satisfactory, and indicates that it is quite safe to send aphis-feeding ladybirds on long journeys without food when a low temperature is maintained. The specimens had been collected during the week prior to their despatch, but each evening those collected during the day had been placed in an ice box; therefore they were chilled and inactive the whole of the time except about thirty hours (of very hot weather) while they were in the hands of the express agency on the way to New York, and for a day or two in England during the change from one boat to another. All of the species are general aphis feeders, and most were taken from pea aphis. I could find no Woolly Aphis at the time from which to collect, but was informed that this pest is preyed upon by *C.* 9-*notata* and two of the other species.

The Assistant Entomologist assumed charge of the specimens on their arrival. He considered it inadvisable to fully liberate any at once, but had enclosures of wire netting made about aphis infested plants within which to start colonies. The netting was designed not only to prevent the escape of the ladybirds, but also to break the force of the winter rains and thus protect the aphides. At Mr. Smuts' estate on Camp Ground Road, Newlands, an orange tree about ten feet high was screened in and stocked with *C.* 9-*notata*; at Capt. Meintje's, Kenilworth, a number of stock plants were covered and given the same species and all the *M. maculata*; at Mr. Rose-Innes's, Kenilworth, seedling cabbage plants were screened and a colony of *C.* 9-*notata* enclosed; the screens in all these cases were tacked over frames erected about the plants. Mr. Henry Meyers, at

Fernwood, Newlands, permitted a large bed of seedling orange trees to be roofed with netting, and therein were placed the species of which there were a few only, and half of the *H. glacialis*. The only liberation made in the open was of twenty *C. 9-notata* on aphis infested roses in the Municipal Gardens, Capetown. The beetles all disappeared from sight within a few days. Two weeks later a specimen of the kind was found on Chrysanthemum Aphis brought to the office from Sea Point by Mr. T. de Villiers. It could only be accounted for by presuming it to be one of those from the Gardens, and if it were, it probably flew or was blown over the Lion's Rump, perhaps a full mile in an air line over the mountain.

None of the colonies placed out of doors seem to have been successful. At Capt. Meintje's, the food supply soon ran short and it was necessary to remove the netting within a month. Some of the *9-notata* may have managed to propagate, but it is hardly probable. The nettings at Mr. Innes's were removed in December, and only a few beetles, no larvæ, were found. The tree at Mr. Smuts' kept infested all of the time by at least a little aphis, but no increase in the number of ladybirds was perceptible, and none at all were found when the netting was ultimately removed, January 15th. The screens at Fernwood were kept on still longer, but at the time of writing it is not certain that any of the species have survived; it is possible, however, that a few *H. glacialis* are still there and propagating. Aphis has been plentiful the whole time.

The work indoors was encouraging for a time. Mr. Mally secured the co-operation of many suburban friends in keeping up the supply of food, and when supplies about Capetown failed, a notice in the daily paper brought country friends to the rescue. But as long as the rearing continued, the care of the creatures was very exacting; they had to be fed at least once a day, and in some cases two, or even three times. The old food had to be removed, the boxes or cages cleaned, and the eggs laid taken away. If eggs were left in twelve hours even, some were almost sure to be devoured by the parent beetle, however plentifully aphis was present. When the eggs began to hatch vigilance was required again, as the first larvæ out

were inclined to begin life by feasting on their helpless brothers just breaking the shells. In November, the question of food supply was simplified by the abundance of pea aphis. Mr. Charles Ayres, the well-known nurseryman, unfortunately for him but the reverse for us, had this insect in his sweet peas at Rosebank, and he kindly gave us permission to visit the garden as often as we pleased, and to take what we wanted of the insect. This kind of aphis falls when disturbed, and it was simply a matter of jarring the plants to get a good supply. For several weeks a pint of solid aphis was gathered daily.

No eggs from any of the species were secured until October 25th, that is until the beetles had been kept at the Cape two full months. Probably most of the specimens would not have oviposited until the coming May had they been subject to the American climatic conditions, but it was somewhat of a disappointment that they did not respond to the relative warmth of our winter and early spring and lay much sooner than they did. *C. 9-notata* began first on the date mentioned; *C.transversoguttata* followed on November 11th, and *H.glacialis* on November 12th. The eggs of all three hatched in five or six days, and eggs from all three were obtained off and on for over a month. The first *C. 9-notata* larvæ became pupæ November 16th, and adults November 23rd.

Everything went well up to the last week in November; then a bacterial disease broke out. It showed first in some pupæ but was soon general among the larvæ and among the adults of the Cape generation. Hundreds of larvæ and as many as fifty beetles were found dead in a single day, and the mortality increased despite of all that we could do. It was evident that none of the species would survive the second generation in confinement. Consequently the heroic measure of liberating all the surviving larvæ was adopted. They were turned out to the number of a thousand or more to care for themselves among the native ladybirds on the aphis infested peas in Mr. Ayres' nursery. But misfortune still followed. The conditions became favourable for the development of a fungus disease (*Entomophthora aphidis*), with which a small percentage of the lice had been affected for over a

fortnight, and this disease then swept the aphis off wholesale so that a week after the larvæ had been liberated on apparently superabundant food, there was nothing left for them to eat other than their own kind. Perhaps a few escaped and we may find progeny from them later, but it seems unlikely. Some eggs had been saved at the office, but the larvæ from those soon succumbed. A few score beetles were kept alive until Christmas and then it was deemed best to turn them loose on pea aphis which was becoming abundant in another Rosebank nursery. It may be that progeny of these are somewhere alive but as in the other case there is little hope of it.

It should have been mentioned that a supplementary sending of *C. 9-notata* and *M.maculata* had been made from America in September. This lot was mixed with the first one. It was small and not of much consequence.

The disease which proved so disastrous to the indoor breeding was encountered a year ago when rearing *Leis conformis* (1899 Report, page 13). It attacks and destroys the larvæ and pupæ of our native species, and is probably introduced to the rearing cages with the food. No method of excluding it has suggested itself. It is not confined to ladybirds as it fatally affects larvæ of *Heliothis armiger* (the "risper" in orchards), *Acræa horta* and *Colias electra*. Cultures have been made which indicate that the disease is the same in all cases. Bacteria of two kinds are present, one a large, long bacillus, and the other, a small, short one; the latter is by far the more abundant and is presumed to be the cause of the trouble. Dr. Robertson of the Veterinary Department kindly made mounts and cultures for us.

None of the species gave indications of fulfilling the conditions necessary to render them more useful to us than our native species. Still it would be unfair to draw conclusions from their behaviour the first year since as they came from the northern hemisphere the seasons were reversed for them. Arrangements are being attempted to import more specimens this year. It will be endeavoured to get those proposed collected very early in the American season so as to get specimens which shall be ready to lay eggs on their arrival. I also have promises

of a sending of *Hippodamia convergens* from Mr E. M. Ehrhorn, the Horticultural Commissioner for Santa Clara County, California. I was unable to get this species at the time of my visit, and it is one I should like to have tried as Mr. Ehrhorn, who is a good emtomologist, tells me it feeds fairly well on the Woolly aphis.

Introductions of Scale-feeding Ladybirds.—The one ladybird above others the writer has wished to see established in South Africa is *Cryptolæmus montrouzieri*, an Australian species that feeds on mealy bugs; this is wanted here to prey on the mealy bug getting troublesome in the Cape district in the vineyards and another species causing much anxiety among the pineapple growers in Bathurst and East London districts. We have several other mealy bugs at the Cape but the two mentioned are the only ones that are at all pestiferous; the natural checks, whatever they be, seem sufficient to keep the others within bounds and might possibly in time prove sufficient for the present exceptions, but discretion prompts the establishment of the ladybird. This creature is said to have suppressed a severe mealy bug infestation in the Hawaiian Islands (see page 4). It was introduced into California, without special reason, I believe, as mealy bugs are not troublesome there, but as a good thing to have at hand for emergency. Professor Alexander Craw, already mentioned, had a small colony at his San Francisco office at the time of my visit, and generously gave me about sixty, nearly all he had, of the adults for sending to the Cape. These were confined for despatch with a plenteous supply of mealy bug on leaves of a palm-like plant in two blotting paper lined boxes, each five inches by five inches by nine inches inside measurement. At the same time Professor Craw gave me about thirty specimens each of *Novius bellus* and *Novius sp.*, the former a red striped ladybird and the latter a black species, both of the same size and closely allied to the well-known *Novius* (*Vedalia*) *cardinalis*, and like it feeding on Australian Bug. These ladybirds I thought it would be well to have in South Africa to supplement the Vedalia, which as many suburbanites know fails to perform its duty in plumbago hedges;

besides they might prove more hardy, it was thought, in the elevated northern districts. The two were packed together with Australian Bug on *Acacia decurrens* twigs in a box similar to those used for the *Cryptolæmus*; and as the twigs were succulent, the precaution was taken of alternating layers of the twigs with layers of absorbent paper. A fourth box was packed with about two hundred specimens of *Rhizobius ventralis*, twenty of *Novius kœbeli*, forty of *Rhizobius lophanthæ*, and ten of *Chilocorus bivulnerus*, with Australian Bug and Black Scale to serve as food. These various species were collected in an Alameda County orchard with the assistance of Professor Craw. *R. ventralis* is a very quick breeder and feeds chiefly on scales like our Brown or Soft Scale. *N. Kœbeli* also breeds quickly and feeds on the Australian Bug. *R. lophanthæ* is a tiny, remarkably active ladybird which attacks various scales; I saw it working very well on *Aspidiotus nerii*, a scale common in the Colony on various plants and often injurious to lemon trees. *Chilocorus bivulnerus* is the only one known positively to be a native American species; it is a general feeder and perhaps the most important of all the American scale attacking ladybirds. It and its very close allies attack the Red Scale, and closely resemble a colonial species (*Chilocorus distigma*) of similar food habits. A fifth box, double the size of the others, was packed with the ordinary Vedalia, larvæ, pupæ and adults of the species on Australian Bug infested Acacia twigs being interlaid with absorbent paper. All of the boxes were of cypress wood one inch in thickness, and were sealed to prevent the escape of any of the insects. That the boxes be small, very strong, and perfectly sealed was stipulated by the steamship company with which I had made arrangements for carrying the boxes from New York to Southampton; the company insisted on the conditions fearing that a box might by some mishap get broken open and the passengers see the insects and mistake them for unmentionables!

The boxes left San Francisco August 29th and arrived at Capetown October 9th; the first week they were exposed to a warm temperature but had the advantages of travelling in the cool chamber thereafter. A somewhat

foul odour emanated from them when they were eventually opened but there was practically no mould. Some of the insects enclosed as food were still alive; the mealy bugs particularly had lasted well. Only three specimens of the *Cryptolæmus* were alive, two of the *Chilocorus*, whilst all of the *N. kœbeli* were dead. The Vedalia travelled best and was used almost at once for filling applications for colonies to suppress Australian Bug outbreaks. The two species of *Novius* in company also were in splendid condition; not many adults were found alive but there was an abundance of larvæ and pupæ which had developed on the way. The two species of *Rhizobius* were still alive in numbers but no count was made.

Prior to my visit I had written to Professor Craw asking his aid and he had written Mr. George Compere (see page 25) requesting him to send us specimens of the *Cryptolæmus* direct from Australia. Mr. Compere complied and despatched a sending of some hundreds of specimens. These he sent by mail as full grown larvæ and pupæ on blotting paper over a mat of moss. His accompanying letter of advice was dated from Sydney, New South Wales, July 12th, and reached here with the specimens on August 21st. The moss was found to be dry when the box was opened but, presumably, it was slightly moistened at the time of the packing. The insects with one exception had transformed to adults on the way, and all but four of the beetles and the one exception, a pupa, had succumbed. The pupa changed to the beetle stage the day after arrival and on the same day two of the beetles died, thus leaving only three specimens. These appeared sickly at first but Mr. Mally succeeded in keeping them alive and in breeding from them. Two chanced to be females. He was also successful in breeding from the three survivors of the Californian sending. Mealy bug from coleus, orange and lemon trees, crotons, ferns, oleanders, pineapple plants, guava trees, grape vines and still other kinds of plants, and the Norfolk Island Pine Scale (*Eriococcus araucariæ*) were used as food. The beetles lay a few eggs at a time among the masses of mealy bugs, and thus young larvæ and old larvæ from one mother are present at the same time; this makes it

difficult to separate successive generations. The beetles of the first Cape generation began to emerge November 12th, that is about twelve weeks of winter and early spring from the time the first beetles were received. As summer has advanced the duration of the larval and pupal stages has shortened and only about six weeks is now necessary for a generation. Strong colonies of the species are now on hand.

Novius bellus and *Novius sp.* have both done fairly well in confinement and specimens have been liberated out of doors in suitable places. Both multiply rapidly. The two specimens of *C.bivulnerus* succumbed without issue. The two species of *Rhizobius* were kept together in jars and fed on Black Scale. Both did well at first, but in the second generation the *R. lophanthæ* all died, and the *ventralis* fell off greatly in numbers. It is not improbable that the bacterial disease noted above was responsible, but the mortality was not observed in time to ascertain if this were the case. The surviving specimens of *ventralis* were given their liberty in the Municipal Gardens, where suitable food and shelter were abundant. None have since been seen, but it is quite probable that a few have survived and propagated. It is an inconspicuous species, therefore hard to find on a plant, and it is said to be disinclined to leave a place as long as it has food in plenty and shelter.

Professor F. M. Webster, the Entomologist of the Ohio Experiment Station, whose opinion in regard to the whole question of natural enemies of scale insects was sought, suggested to me that we might find *Pentilia misella* of considerable value for feeding on the Red Scale. This is a very tiny, black ladybird, hardly larger than the head of a pin, that preys industriously and with good effect on the San Jose Scale in the eastern United States. Whilst not able to suppress its host, it acts as an important check. It also attacks other scales, and, in fact, was well known before the San Jose Scale appeared in the east. Therefore there seemed a chance that it would take to the Red Scale with us. Professor Webster very kindly sent his assistant to a distant corner of the State, where he knew the species could be obtained, and had several hundred specimens

collected for me. These I received on my return from California, and sent to the Cape with the second lot of aphis feeders. Every specimen, however, died on the way. Later in the season Professor Webster tried again. He had about twelve hundred collected and packed with crumpled bits of paper in a tin box, which measured about four by six by ten inches. The lid was soldered on, and hence no fresh air nor moisture could obtain access. The box was sent, as were the previous ones, in the care of the Agent-General for the Colony at London, and travelled in the cool chamber of both carrying vessels. It reached Capetown on December 6th, thirty-six days from the date of its despatch from Ohio. As was expected, most of the beetles succumbed, but about five hundred living ones were found hidden in the creases of the paper. These survivors were placed in jars with scale of different kinds. Some specimens appeared to eat, but most clustered in the corners as if desirous to hibernate. No inclination to lay eggs was manifested, and day by day the numbers grew less. They seemed to like Red Scale as well as any kind, and, thinking they might fare better out of doors, half of them were given liberty on a small lemon tree, badly infested with Red Scale, at Kenilworth. These were not to be found a few days later, and have probably been lost entirely. Those remaining at the office continued to die off, and after a fortnight they were placed in a sheltered nook of the Gardens near where *R. ventralis* was liberated. As none had showed any disposition to oviposit, it is feared that they have failed to establish their kind. It would be well worth the trouble, I think, to make other trials with the species; perhaps it would be better to get them in the American spring, as they then would be more apt to lay shortly after their arrival.

It may be well to state in closing these notes relative to beneficial insects that the present knowledge of insects predatory and parasitic on other insects, is very deficient. While it may be known very well that a certain species of parasite, for instance, is very active in attacking a certain plant-feeding pest, and thus apparently holding that pest in suppression in some seasons, almost nothing at all may be known relative to that parasite's habits, nor any other

knowledge that would guide one in an effort to transfer that parasite alive to a distant land. Thus, in the United States a certain parasite is known to affect the eggs of the Pear Slug (*Eriocampoides limacina*). The Slug there is not nearly the injurious insect it is with us. The parasite, therefore, might prove a valuable acquisition in the Colony. How to intelligently attempt its introduction, however, is beyond our ken. Careful investigation might disclose a simple way, but the investigation would necessarily be very costly in time and trouble, and in the end might lead to no good so far as helping us is concerned. A hundred years hence sufficient knowledge in regard to where such parasites are to be found when their now known hosts are gone, and other essential particulars of the life history, may have accumulated, so that an entomologist of that time may be able to deduce at once whether or not their successful exportation is practicable. At present, too, it is not known to what extent most parasites are responsible for the suppression of their hosts. In the instance cited it may be that careful study would disclose that the parasite is only a minor agency, whilst peculiar climatic factors or degeneration of the pest through obscure causes was chiefly responsible. This paragraph is inserted here because many of our fruit-growers have the idea that finding and introducing efficient natural enemies of insects is a very simple matter, and that the suppression of their pests in that way would be inexpensive.

INSECT LEGISLATION.

As was announced last year, the subject of insect legislation for the protection of horticultural interests will be given a prominent position in my annual reports until we have acceptable measures enacted or until the matter loses its interest entirely to the progressive fruit-growers. As formerly, the three phases of the subject will be dealt with separately; and, as appendices to the report, copies of the legislative measures proposed will be given.

The Nurseries Bill.—It is now seven years since agitation for legislation that would minimise the growing evil of

spreading pests with nursery stock was started, and five years since the present Bill was drafted by the Western Province Board of Horticulture. The text of the Bill is given in full in the appendix, and explanations of the text and arguments for the passage of the measure have occupied much space in the report for every year since 1895. To every right-minded fruit-grower and nurseryman who has read these discussions it has been shown conclusively, the writer believes, that the Colony is in sore need of legislation such as is proposed. This legislation has the object of restricting to the maximum degree practicable the dissemination of pests from our nurseries, and of there detecting and, if possible, of eradicating newly-introduced pests. The details of the Bill are framed to accomplish the objects with the least possible trouble and expense to the nurseryman compatible with success and are in no wise harsh or irrational. Other countries have fully demonstrated the usefulness of nursery inspection, and hence procrastination in enacting similar laws here cannot be justified by the plea that such would be impracticable and without precedent.

With each year of no effective legislation the dissemination of pests and diseases of orchard trees and fruits increases and becomes more and more difficult to effectually check. Under the political conditions of the Colony, the people most concerned, the fruit growers, are those most to blame for the continuance of the grievous inaction. If they, the fruit growers, would earnestly demand nursery inspection, the Government would quickly accede. But to all appearances the great mass of them are content with criticising and thus retarding, or at the best inefficiently supporting the measures which are proposed; and when, in a few years, they are goaded into concrete action by the expense of dealing with pests new to their orchards, it can only be expected they will blame the Government and its experts for the costly delay for which they themselves are almost wholly responsible. Meanwhile such occurrences as the following, reported by the secretary of the Oudtshoorn Fruit Growers' Association in a recent letter, will be frequent: "I am sending you a white scale for identification. I strongly suspect it to be *Diaspis amygdali*,

a pest I have not noticed here before. It was introduced into this district by a Calitzdorp orchardist who got some peach and plum trees from a nursery in the metropolitan province."

The proposed measure requires that the removal of stock from pest infected sections of nurseries be stopped until the pests be exterminated and a certificate to that effect be given by the Government inspector. This precautionary quarantine I believe to be necessary to best safeguard the interests of the fruit growers. But material benefit could doubtless be derived from less drastic requirements, and rather than have the horticultural interests suffer from longer delay, I strongly recommend that in case the Bill as it stands fails this year to get through Parliament, immediate action be taken to urge a modification of it that cannot fail to get the necessary support. Compulsory fumigation in a prescribed manner of all nursery stock as it leaves the nursery to ensure the destruction of infesting scale insects might be demanded and this requirement of them would meet with objection from few nurserymen. Neither could much objection be made to a periodical inspection of all nurseries by a Government officer having a knowledge of insects and diseases liable to be spread with nursery stock, if such inspections were to be conducted solely to acquaint the nurseryman with the pests present on his grounds; and if made cognizant of the pests and informed how best to treat them, the majority of our nurserymen would take some steps to remedy matters. Having thus introduced nursery legislation and accustomed those affected to it, it might not prove difficult to secure amendments that would make the law all that is desired for the objects now in view.

Orchard Pest Bill.—The proposed "Plant Pests and Diseases Bill," prepared by the Western Province Horticultural Board two years ago and supported by the Eastern Province Horticultural Board at a meeting held at Queenstown in July, 1899, was brought up for discussion by the fruit growers, both western and eastern, at their annual conferences this past year. The Western Province fruit growers voted to postpone consideration of the measure for

a year. The Eastern Province fruit growers voted to withhold their support because the measure was drafted on "permissive" and not "compulsory" lines. The Bill, it may be well to review, authorises the formation of local horticultural commissions in districts or wards of districts in which the local Fruit Growers' Association or Agricultural Association requests the enforcement of the permissive clauses. These local commissions are empowered to have all the properties within the area for which they are appointed inspected to ascertain their condition as regards insects and plant diseases deemed pestiferous, and to compel occupiers to apply prescribed remedies for such evils should they be considered a public menace. There are two sections compulsory for the whole Colony; one authorising the Minister for Agriculture to have action taken to suppress any exceptionally injurious pest of limited distribution; and the other prohibiting the transport in public conveyances and the sale in public markets of fruit infested with the Codling Moth or with living scale insects.

The object of the proposed measure, as may be readily deduced, is to check the dissemination of pests from orchards and from fruit sent from the premises. Thus it supplements the proposed Nursery Inspection measure. The pests such as scale insects and plant lice which are spread in a wholesale manner from nurseries tend to spread slowly from orchards in which they become established to surrounding premises. Then there are other orchard insect pests that are rarely spread with nursery stock but which spread more or less freely from orchard to orchard by virtue of their wing power; the Pear Slug may be cited as an example. Then there is a third class of insect pest, which like the second may fly from farm to farm, and which may also be disseminated in a wholesale manner by accompanying consignments of fruit; such is the Codling Moth and the Fruit Fly. In so far as the last class of the pests is concerned, the fruit grower plays a part analogous to that played by the nurseryman in the dissemination of pests that spread with nursery stock. The chief difference between the two cases is that the nursery evil is both the greater in importance and the

more easy to remedy. As regards the first two classes of pests, there is far less need for legislation; and except in strictly fruit growing sections of the country legislation for their control seems, to the writer, not only unnecessary but actually undesirable, among other good reasons because the expense of enforcing effective legislation would be entirely disproportionate to the benefits derivable. I believe the Eastern Province fruit growers to be therefore unreasonable in wanting the permissive features of the Bill made compulsory.

Whilst visiting California this last year I took the opportunity to observe the workings of the orchard legislation in force there. The Californian law is a permissive one with the county as the unit. The counties are about as large as our districts and in many respects correspond to them. The primary law was enacted twenty years ago and has been amended several times, but there has been no interference with its permissive character. Some counties have the legislation in force and some have not, largely dependent on the local interest in horticulture. This order of things seems very satisfactory. Where fruit growing is pre-eminently the business of the people, the legislation is strictly enforced and is seen at once by the observer to be an instrument of immense value to the community; in general, any man that neglects insect pests in his orchards is deemed to be maintaining a public nuisance and is prosecuted accordingly should he fail to apply remedies as demanded by the horticultural commissioners But in counties where fruit growing ranks as a minor pursuit public sentiment is not strong enough to enable the horticultural commissioners to force the orchardists to deal with ordinary pests, and they are forced to modify their work to disseminating useful information in regard to remedies for the pests, introducing and assisting the establishment of beneficial insects, guarding against the importation of new pests to their area, and otherwise rendering themselves generally useful to the horticultural interests they represent.

Personally, the writer favours the measure as drafted by the Western Province Board of Horticulture, but deems it of small importance compared with the Nurseries Inspection and Quarantine Bill.

Import Regulations.—The Colony has serviceable regulations governing the introduction of foreign grown plants and fruits, but it was pointed out two years ago that these regulations should be amended in several respects. A draft schedule embodying the proposed changes was drawn up by the Western Province Horticultural Board, and at this time, a year ago, it seemed as if the draft would be adopted. Delays, however, have taken place, and at the time of writing there is still some uncertainty what course the Government will follow. Imports of fruits would not be affected by the changes proposed, but imports of fruit trees would be limited to new varieties, and these only allowed entrance in small numbers, and under special permits. Introductions of stone fruit trees, now wholly prohibited, would be permitted on the same terms as other fruit trees if accompanied by a declaration certifying that the stock was not grown in states or provinces of the United States or Canada where the diseases peach yellows and peach rosette occur. The further introduction of peach stocks from anywhere would be prohibited after due notice. And lastly, the Examining Officer would be given the authority to fumigate all imported trees whether or not he found pestiferous insects.

The first amendment is desired to further minimize the risk which is always present, however careful and competent be the Examining Officer, of introducing new pests and diseases. Many of the worst pests which we are striving to keep out are inconspicuous on their food plants, and owing to the generally soiled and often musty condition of imported trees on their arrival here a slight infestation by these insects might be easily overlooked even in a most painstaking inspection. Fumigation with hydrocyanic acid gas might catch these but fumigation must not be considered infallible. Then again, there are a number of serious plant diseases that cannot be detected in dormant stock. To some measure these objections apply to small consignments such as would be permitted under the proposed revised regulations, but the Examining Officer could take time to critically inspect every particle of surface in the case of a few trees when such scrutiny would be obviously impracticable in the case of a large number of

trees. Moreover, trees of varieties new to the Colony, as all would be under the amendment, would almost to a certainty be carefully selected stock from the best nurseries.

The second amendment, that to permit of a limited introduction of stone fruit trees of new varieties from the United States and Canada, is to relieve our fruit growers and nurserymen of a wholly unnecessary and harmful restriction, the *pros* and *cons* of which were discussed in the writer's 1898 report.

The amendment to prohibit the introduction of peach stocks is urged by the Western Province Horticultural Board after a careful consideration of the matter and consultation with several nurserymen. It appears that peach stocks may be successfully grown in the Colony from seed, and hence that there is no necessity to import stocks. The objection to importing them is, of course, the attendant danger of incidentally intoducing plant pests and diseases new to us. Owing to the great number of fruit tree stocks in consignments, sometimes hundreds of thousands, it is obviously impossible to fully determine on the absence of injurious insects.

The final amendment noted, that giving the Examining Officer the authority to fumigate trees irrespective of finding injurious insects, is needed, not so much for fruit trees, in case the amendments are accepted, as for hardy plants other than fruit trees which would still be allowed introduction in unrestricted numbers.

The wisdom of the proposition to limit the importations of fruit trees to a few plants of new varieties is questioned by a certain section of the Eastern Province fruit growers on the ground that the colonial nurserymen would thus receive unwarranted protection from foreign competition. But in addition to the indisputable fact that the introduction of the foreign grown trees in quantities is attended with grave risks to our horticultural interests, it may be said in support of the restriction against this charge that the colonial nursery business has reached a stage at which honest competition within our borders is sufficient to guard against exorbitant charges. The colonial nuseryman, it is true, cannot afford to sell his trees at the low rates current in Australia and America; but, all the facts considered,

colonial grown trees from a high-class nursery, at colonial prices, are far preferable for the South African farmer to foreign grown trees of the same varieties, at the lowest cost at which it is possible to land them. Then again it is sincerely hoped that before long we shall have nursery legislation in force in the Colony, and in fairness to our nurserymen we should have regulations of equal stringency and efficiency governing the importation of stock.

MISCELLANEOUS INSECT NOTES.

Codling Moth.—The indications are now that in a very few years the whole of the south-western districts of the Colony will be no better off than California and South Australia as regards this pest of apples and pears; in other words, it will be a case of thorough spraying with arsenicals or the infestation of the bulk of the crop. Legislation to restrict the spread of the insect in this part of the Colony would now prove of little avail, although doubtless enforced prohibition of the sale of infested fruit would have the effect of inducing many fruit growers to combat the pest, who, without the law, would do nothing at all to lessen its ravages, and would thereby assist the progressive fruit grower on neighbouring property to keep the pest down in his orchards.

Growers of fruit in Uitenhage, Albany, Bathurst, and other south-eastern districts where horticulture ranks as a commercial pursuit, had well give this pest their attention, ascertain by comparison of notes and examination of their orchards if it has reached them, and, if it has not, to insist that no apples or pears, or other fruit if infested, be allowed to come into their districts from infected ones. Graaff-Reinet, and the country for thirty, forty, or more miles around is more or less badly infested; the town itself has long harboured the pest, and it is said that fruit is sent from there to Uitenhage and Port Elizabeth. Other things being equal, fruit-growing areas without the Codling Moth will have a very decided advantage over those that become troubled with it, and this fact should arouse local interest in keeping out the pest.

Fruit Fly.—The Fruit Fly (*Ceratitis capitata*) did little damage in the south-west last year, and it is again fortunately less numerous than in the average season this year (1900-1901). By the irony of fate, however, peaches as well are scarce. If a goodly number of flies can be obtained late in the season, another attempt to ascertain if any can survive the winter will be made. A cage, six feet square by four feet high, in which to confine flies for the experiment has been erected at Newlands. Several attempts have been made in the past to carry flies over, but always in small cages. One of a number of flies bred from late apples last year survived in a cage slung to a tree at Rosebank at least up to September 8th. Its companions died off one by one through the winter, many of them from getting their heads caught in the netting.

The Natal Entomologist, Mr. Claude Fuller, has discovered that an allied fruit fly is prevalent in Natal. We have one about Capetown that is very closely allied to it in the blackberries, and doubtless many a berry containing the maggot is eaten. Mr. Fuller writes that the Natal species does not appear to molest blackberries, but that "it goes religiously for everything else, including red, yellow, and white guavas." It also infests the berries of a high-growing Solanum (*Solanum giganteum Jacq.*), a plant which is common in waste land and old gardens about Capetown; and it appears partial to Japanese plums, fruits which are practically exempt, so far as our experience thus far goes, from the attack of the common fruit fly. The blackberry species was determined by Mr. D. W. Coquillet, of the U. S. Department of Agriculture, as a species of *Trypeta* near *penicellata* Bigot. The same authority from a casual examination of the Natal species was unable to distinguish it from the blackberry one, but he may discover differences on closer study.

Another Trypetid fly, not mentioned in these reports before, but noticed for two or three years past in the Cape district, has this season infested a great many melons and other cucurbs in the suburbs of Capetown. The fly has not yet been determined, and was not represented in the collections of the United States National Museum. It is wasp-like in general appearance, barely a half-inch in

length of body, and brown in colour, with golden pubescence; there is a conspicuous black patch broken by a colourless stripe at the end of the wing. It appears to successfully attack hard and nearly mature fruits as well as soft young ones; recently hatched maggots have been found in a hard pumpkin bought from the greengrocer. This species is quite distinct from the smaller one (*Dacus ferrugineus*) that also infests cucurbs.

Fruit Moth.—An extraordinary abundance of fruit injuring moths was reported from various parts of the eastern half of the Colony during the last fruit season, especially in the month of May. Numerous specimens were received at the office from correspondents and all of these were found to be of one species which was determined at the South African Museum to be *Ophiuza lienardi*. The farthest point westward from which we recorded the insect is Humansdorp; the most northern point, Graaff-Reinet, and the most eastern, Umtata. Komgha and East London districts, to judge from the number of complaints made from them, were the centre of the plague. The insect also attracted attention in Natal, the determination of the species there being made from specimens, named by Mr. W. L. Distant, deposited in the Durban Museum. Apples, pears, plums, grapes, peaches, figs, oranges, guavas, bananas, loquats and medlars were reported to be attacked; one or two parties also included the pineapple among the fruits injured, and one mentioned cabbages, berries, flowers and mealies as being among the sufferers. There seems to be no doubt whatever that the moths pierced perfectly sound fruit. Notes on the occurrence of the pest found their way into English scientific journals; but nothing, so far as we have learned, has been recorded relative to the larva of this extraordinary pest. *Ophiuza lienardi* was the only species represented amongst the specimens sent to this office; but an English entomologist of note, Mr. C. G. Barrett, records several other species as concerned in the work of destruction. His information and specimens of the insects were secured through his sister, Miss Frances Barrett, who was a visitor to South Africa at the time. Miss Barrett found *Sphingomorpha monteironis* taking a

particularly prominent part and considers it the principal species; and it at least she saw actually bore with its proboscis into a sound fruit. (See *Entomologist's Monthly Magazine*, June, July and September, 1900; *Entomologist*, July, 1900; *Nature*, May 31st, 1900; *C.G.H. Agricultural Journal*, July 5th, 1900; and *Natal Agricultural Journal*, January 18th, 1901.)

Orange Worm.—The term "Orange Worm" will be used for the time being to designate a caterpillar, yet unidentified, that is beginning to attract attention in the far east of the Colony as an insect infesting the orange. The caterpillar was first noticed four years ago in the naartjes at East London; and we have since suspected that it occasions much of the damage to the citrus fruits in eastern sections attributed to the Fruit Fly. This year a single specimen was reared from oranges sent from Komgha; it was sent to the British Museum to be determined, but unfortunately it became damaged after arrival and could not be identified. The moth is about the size of the Codling Moth and somewhat like that insect in general appearance. Mr. Fuller has found the same insect about Maritzburg, in Natal, and has reared it from apricots, peaches, guavas, oranges, and mandarins. The term "Orange Worm" is used by him in discussing it in the *Natal Agricultural Journal* for May 11th, 1900. The infested fruit falls from the trees, and Mr. Fuller recommends, as a remedy, that the fallen fruit be gathered and effectually disposed of daily.

Grain Bug.—This is another yet unidentified insect that appears to possess potentialities as a pest. It is an ally to the infamous Chinch Bug of America, and in size, markings and colouration is strikingly like the False Chinch Bug of America, *Nysius angustatus*. Despite its small size it appears a formidable enemy to its food plants and has aroused the attention of farmers over much of the Colony this past year. It has been sent to the office from Upington, Queenstown, Graaff-Reinet, George, Worcester and other districts, and is observed to be not uncommon about Capetown. Its ravages to wheat and oats suggests the name by which it is here designated, but it is said by

correspondents to seriously damage potatoes, and is frequently taken about Capetown from other Solanaceous plants. Infested grain is sometimes sucked dry and large patches thus rendered worthless. (See *Agricultural Journal*, November 9th, 1899, page 664.)

Heliothis armiger.—This "risper" pest, so abundant and injurious in the south-western districts in the early summer of 1899-1900 and destructive to the buds, young foliage, and newly formed fruit of fruit trees, to tomatoes, and peas, was conspicuous by its scarcity this summer in the Cape and adjacent districts. It is a pest that is found more or less through all the agricultural portions of the Colony. It was part of the office plan to study the insect and test insecticides for its destruction. Some spraying experiments were conducted in October by the Assistant Entomologist at Wellington, with the kind co-operation of Mr. Roland Taylor, but the experiments practically failed owing to a considerable percentage of the caterpillars proving to be parasitized by Tachinid flies. It is naturally conjectured that the parasite was a leading factor in keeping the insect in subjection this season.

Heliothis armiger is an almost cosmopolitan insect, but it is not recorded to be a fruit and fruit tree pest of consequence other than at the Cape and in Western Australia.

Diamond Back Moth.—Probably all of our farmers know the Diamond Back Moth (*Plutella cruciferarum*) by sight if not by name. It is the tiny, wriggling caterpillar that eats away the surface of the leaves of cabbage, turnips and other cruciferous plants, and is later seen as a pupa in a neat, lace-like cocoon attached to the plant. The moth, too, is well known, not only amongst the plants but about the flame of candles at night. The name by which the insect is here designated is suggested by the shape the white markings on the wings of the moth assume when the creature is at rest. The last spring was marked by an extreme abundance of the insect, both in the east and west of the Colony, and many fields of cabbages were quite destroyed. No remedial measure is generally practised, and that we might be in a position to recommend one from experience, some spraying experiments with arsenicals

were made by the Assistant Entomologist in late October at Elsenburg. Some plots of kohl-rabi and Swedish turnips were treated with arsenate of lead mixed with very dilute resin wash. The spray, thanks to the resin, adhered to the foliage and seemed to be acting effectually in destroying the insects. But, unfortunately for the experiment, a fungus disease appeared amongst the caterpillars and swept them off wholesale, so that no deductions on the actual value of the spraying could be made. We are told by a Uitenhage correspondent that he saved a cabbage crop valued at £400 by timely spraying with Paris green; his neighbours, he says, suffered severe losses whilst his plants quickly outgrew the injury that had been inflicted.

Loquat Worm.—In October, 1899, a minute caterpillar was found to be doing some damage to loquats in gardens back of Cape Town; and the same insect was found by the Assistant Entomologist to be very abundant on loquats in the suburbs during the past September. He noted that the caterpillar does not live in the pulp, but spins a web between contiguous fruits and from this protection gnaws into the surrounding fruits, often to the pips. The castings lodge in the web and thereby lend to the disfigurement of the fruit cluster. Nothing was seen of the insect from the end of the loquat season up to the middle of February when it was found abundant along the edges of a Constantia vineyard in pontac grapes. Many bunches were quite covered with webs and castings, and the berries all destroyed. Moths have been reared in abundance and from these the determination of the species will soon be made. Specimens of two species of parasites which attack the caterpillar have incidentally been secured, and it seems likely that such parasitism serves to hold in check what would otherwise prove a very serious grape pest.

Pea Aphis.—The Pea Aphis is mentioned principally to record its presence at the Cape. It has been noticed by the writer each year since 1895, the year he came to the Colony, on sweet peas in suburban gardens; and it is probably an insect that has long been established here. This year it can hardly be said to have been more abundant than usual. In some gardens the sweet peas escaped its

attack altogether until very late in the season, but in others it appeared early and destroyed the plants before they blossomed. The last week in October is generally the time when the insect begins to attract attention, but some of it is usually to be found five or six weeks earlier. The chief interest attaching to the insect is that it is identical with the destructive pea aphis of Europe (*Nectarophora pisi*) which for long has been known as a severe pest to field peas; also that it now appears to be identical with the species which has ravaged American pea fields for the past two years. The American crop is used largely by canneries, and the losses through the insect have been very considerable; the direct loss of the peas alone is estimated at over £1,250,000. About Capetown the insect multiplies prodigiously when the conditions favour it. Several species of ladybirds and other predaceous insects feed on it voraciously, but its chief natural enemy is a fungus disease which, to judge from this year's observations, is generally present and capable of sweeping off a severe infestation of the aphides in a few days when damp, warm weather, not necessarily rainy, prevails. The aphides attacked turn from their natural green to brownish, swell up, become velvet-like to the sight, and finally shrivel. Specimens destroyed by the disease were sent to Dr. Roland Thaxter of Harvard University (U.S.A.). He kindly examined the material and reported that he found the fungus to be *Entomophthora aphidis*, a species which serves as a check on the same and other aphides in Europe and America.

Orthezia insignis.—Extended mention was made of *Orthezia insignis* in the *Agricultural Journal* three years ago; it was then feared that the scale might assume the proportions of a pest in this Colony as it has in Ceylon. It was also figured and described in the writer's report for 1898. It is a scale insect of the nature of the well known Australian Bug (*Icerya purchasi*) but is only a fraction of the size of that species. The fears that it will become a serious pest have been somewhat allayed by finding it in a lantana hedge at Mowbray where, the coloured tenant of a cottage behind the hedge gave me to understand, it has been established for many years. The attention of the owner was called to the insect and he was recommended

to have the hedge uprooted and burned at once. He promised to follow the suggestion but the hedge still remains and testifies to the need of a governmental regulation authorizing the destruction of plants infested by possibly dangerous insects whose distribution is known to be very limited. The neighbourhood is visited from time to time and should the insect be found to spread we are quite sure the owner will not longer delay in having the hedge removed. No parasites have been reared from the insect and ladybirds appear to leave it severely alone.

Other Scale Insects.—The Mealy Bug of the Grape (*Dactylopius sp.*), known in Constantia for an indefinite period, and for five years certainly, has now been reported from Somerset West. Whether or not it will prove a pest of importance remains to be seen, but for two or three seasons it has inflicted rather serious injury to some vineyards near Diep River and Retreat. The insects cluster in the bunches and foul them with their honeydew, on which thrives the still more objectionable soot-like fungus (*Capnodium sp.*). They also appear to affect the wood by their attack in great numbers. In the winter rough bark shelters the hibernating individuals not only from cold and wet but from insecticides applied to destroy them and to some extent from predaceous insects. To remove the loose bark is a costly operation and is not wholly effectual in exposing the insects. The Assistant Entomologist experimented with insecticidal washes during the past winter but the work does not admit of definite conclusions as the insects did not appear in numbers, when summer came, on the vines surrounding those sprayed. As noted elsewhere in this report, attempts are being made to establish an imported ladybird, *Cryptolæmus montrouzieri*, in the vineyards, and if these attempts are successful it is probable that complaints of severe infestation will soon be infrequent. A very tiny, native ladybird preys industriously on the mealy bug and multiplies rapidly at its expense; but the larvæ of the ladybird are themselves the prey of a vigilant parasite.

The mealy bug (*Dactylopius bromeliæ ?*) that attacks the pine-apple in the East London and Bathurst pineries has begun to excite apprehension amongst the growers in the

latter district, and prominent men among them have been agitating for the destruction of the infested pineries. The plants practically cease to bear when they become badly infested, and the fruit of affected plants becomes disfigured with clusters of the insect around the base, and in the cavities of the flowerlets. An effort to establish the *Cryptolæmus* ladybird in Bathurst will shortly be made. It has been demonstrated experimentally that the ladybird will attack the mealy bug; but there is small likelihood that the latter can be held in close suppression by the former since it can creep into and breed in cavities of the plant inaccessible to its larger foe.

The phylloxera inspectors in their work at Constantia early last year discovered a remarkable coccid on the roots of vines in one of the vineyards on the farm "Klein Constantia." The vines were unhealthy in appearance and it was at first surmised that the insect was the responsible agent, but it was later determined that other factors were partly if not wholly the cause. The writer visited the farm and secured specimens of the new insect; and on examining these found them to belong to a new genus. An authority on scale insects, Professor T. D. A. Cockerell of New Mexico, was appealed to, and this gentleman described the species under the name of *Cryptinglisia lounsburyi*. The insect is hidden within a firm, irregularly rounded scale covering, a sixth of an inch or less in diameter, which resembles the root in colour and in which are embedded particles of soil. These gall-like formations are sometimes contiguous and the roots then have the superficial appearance of being badly infested with nematode worms whose nodular galls are occasionally seen on the vine at Constantia and elsewhere in the Colony.

Locusts.—For future reference the continued presence of migratory locusts in the east of the Colony is here recorded. Both the Red Wing Locust, *Acridium purpuriferum*, and the Old or Brown Locust, *Pachytylus capensis*, have been the subject of many complaints to the Department. The swarms in most cases at least appear to have originated within our own borders. The whole question of locusts should be given serious attention by Parliament,

for the Colony will always be subject to invasions, and the artificial distribution of the disease fungus gives no promise of ever proving adequate as a remedy. The country is sadly in need of a comprehensive law clearly defining amongst other things just what assistance the Government will render in the destruction of swarms. The law might not be needed for years but the machinery to render it effective should be in constant readiness. In view of the probable influx of agriculturists after the war the subject is now specially urgent; a visitation of locusts, due to the country's neglect, is a misfortune which will surely almost dishearten a new colonist.

Fly parasites of the locusts appear to be on the increase, as reports of affected swarms have become common and numerous specimens have reached the Department. It is, however, impossible to judge from the reports how seriously the swarms suffer as a whole from this cause. The infested individuals, as they weaken, naturally drop behind their fellows and thereby command attention. The birds must devour many of the doomed ones and with them the contained parasites.

APPENDICES.

APPENDIX A.—Nursery Inspection and Quarantine Bill.

Draft supported by Boards of Horticulture.

BILL

TO

Check the Dissemination of Insect Pests and Plant Diseases from Nurseries of Plants and Trees.

Preamble.—Be it enacted by the Governor of the Cape of Good Hope, with the advice and consent of the Legislative Council and House of Assembly thereof, as follows:—

1. *Repeal of Repugnant Laws.*—So much of any law as may be repugnant to or inconsistent with the provisions of this Act is hereby repealed.

2. *Interpretation Clause.*—For the purposes of this Act the following terms within inverted commas shall, if not inconsistent with the context and subject matter, have the meanings hereby respectively assigned to them; that is to say:—

"Nursery" shall mean any land or premises whereon are grown or cultivated any fruit or other trees, perennial shrubs or plants intended for sale or distribution for the purpose of being grown elsewhere.

"Insect Pest" shall signify any insect which the Governor may from time to time by proclamation declare to be an insect pest within the meaning of this Act.

"Plant Disease" shall mean any fungoid or other disease which the Governor may from time to time by proclamation declare to be a plant disease within the meaning of this Act.

3. *Registration of Nurseries.*—Every nursery shall be registered by the owner or occupier thereof, at the office of the Resident Magistrate or Assistant Resident Magistrate of the district wherein such nursery is located, on or before the 15th of January in each year; and a general registration fee of £1 per annum shall be paid by the owner or occupier in respect of any nurseries owned or occupied by him in such district.

4. *Inspection of Nurseries.*—Every nursery shall be inspected at least twice a year by an officer appointed for the purpose by the Minister; but, unless deemed absolutely necessary by the Minister, no inspection shall be made during such period between 1st of May and 1st of October, as shall be fixed for the different areas by proclamation by the Governor.

5. *Duty of Inspector.*—It shall be the duty of the inspecting officer to declare under quarantine such part of any nursery as lies within eight (8) yards of any tree or plant which he finds infested with any insect pest or plant disease, or within twelve (12) yards if such infested tree or plant is over ten (10) feet in height; and such area shall be held and deemed to be under quarantine accordingly.

6. *Quarantine, Continuation of.*—A quarantine proclaimed under the preceding section shall remain in force until the inspecting officer shall at a subsequent regular inspection, or at an authorised examination as provided for in section 7 hereof, find the trees or plants within such quarantined area free from insect pest or plant disease, and shall have given his written certificate to that effect to the owner or occupier of the nursery affected; and during such period of quarantine it shall not be lawful for any person to remove or cause to be removed any nursery stock or any plant or any portion thereof from the quarantined area.

7. *Authorised Examination.*—Any owner or occupier of a nursery having his nursery or any part thereof thus placed under quarantine, may, upon application to the Minister, have his nursery examined free of charge prior to the next regular inspection, to determine whether or not he has been successful in eradicating the insect pest or plant disease, but such owner or occupier must certify that a period

of six weeks has elapsed since the last application of the remedy. If additional examinations are desired, they will be made under the same conditions, but at the expense of the owner or occupier; and any person who shall give a false certificate under this section shall be deemed to be guilty of a contravention of this Act.

8. *Destruction of Plants, &c.*—Nothing in the foregoing sections shall prevent any inspecting officer from ordering and causing to be carried into effect the immediate destruction of any plants or trees in any nursery which he finds infested by any insect specially dangerous, or other animal pest, or by any plant disease, whether the same has been proclaimed or not proclaimed as such under section 2 of this Act, should he deem such action advisable; provided, however, that any dispute as to the justification of such a measure shall be referred for decision to a committee composed of three members, one of whom shall be appointed by the Secretary for Agriculture, one by the Horticultural Board, and one by the local Fruit Growers' Association, or should no such society exist in the district, by the local Agricultural Society, or in default of such Agricultural Society by the Horticultural Board. Neither the inspecting officer nor the owner or occupier concerned shall be eligible for appointment on the said committee. The decision of the committee must be given within three weeks, and shall be final; and until such decision has been obtained the infested portion or portions of the nursery shall be declared and held to be under quarantine as provided for in section 5 of this Act.

9. *Entry upon Lands.*—It shall be lawful for any officer duly appointed thereto by the Minister, to enter upon any land, and to do thereon such acts, matters and things as are necessary or reasonably required for carrying out the provisions of this Act, and any person obstructing, resisting or interfering with any such officer in the lawful execution of his duty, shall be deemed to be guilty of a contravention of this Act.

10. *Rules and Regulations.*—It shall be lawful for the Governor by proclamation to make, alter or revoke such rules and regulations for the purpose of carrying out the provisions of this Act as may from time to time be deemed expedient, and impose penalties for the contravention thereof not exceeding a fine of ——

11. *Penalty Clause.*—Any person contravening any of the provisions of this Act, or of any rule or regulation duly made and published thereunder, shall be liable to the particular penalty on that behalf prescribed, or if no particular penalty be prescribed, then to a penalty not exceeding ——

12. *Short Title.*—This Act may be cited as "The Nurseries Inspection and Quarantine Act, ."

APPENDIX B.—Plant Pests and Diseases Bill.

BILL

TO

Prevent the Spread of Plant Pests and Diseases.

Drawn up by the Board of Horticulture for the Western Districts, and printed for distribution among Fruit Growers' Associations for their observations and suggestions.

BE it enacted by the Governor of the Cape of Good Hope, with the advice and consent of the Legislative Council and House of Assembly thereof, as follows:—

1. So much of any law as may be repugnant to or inconsistent with the provisions of this Act is hereby repealed.

2. For the purposes of this Act the terms "plant pest" and "plant disease" shall signify any pest or disease injurious to cultivated plants.

3. The provisions of this Act shall be in force in such districts, or wards of a district, as the Governor may by Proclamation in the *Gazette* prescribe, except sections 8 and 12, which will be in force throughout the Colony: provided that no such Proclamation shall issue in respect of any district or ward, except upon the

recommendation duly made in writing of the local fruit growers' association or agricultural association in such district or ward: and provided further that it shall be lawful for the Governor, upon a like recommendation, to revoke any Proclamation issued in respect of any district or ward, and thereupon the provisions of this Act shall no longer be in force in such district or ward.

4. Upon the provisions of this Act being put into force in any district or ward, a Horticultural Commission shall be appointed by the Minister for Agriculture, consisting of three persons, being *bona fide* fruit-growers, one person to be selected by the Resident Magistrate of the District, and two persons to be selected by the local fruit-growers' association or agricultural association. Should such association be represented on the Board of Horticulture, then one of the persons to be selected by such association shall be one of the members representing such association upon the Board of Horticulture. The Horticultural Commission shall be appointed biennially, the retiring members to be eligible for re-election.

5. Such Horticultural Commission shall, as soon as may be after being so appointed, take such steps as may be deemed to be necessary for ascertaining and verifying the existence of any plant pest or disease, as may come or be brought to the notice of any of the members.

6. Whenever it shall be proved to the satisfaction of such Commission that any such pest or disease exists on any tree or plant on any property or place within such district or ward, and they shall be of opinion that such pest or disease threatens or is likely to spread and be injurious to other trees and plants, it shall be the duty of such Commission to give notice to the owner or occupier of such property or place to take such steps as the Commission may prescribe for dealing with such pest or disease, within a given period to be fixed by the Commission: and in default of any such owner or occupier taking such steps for dealing with the said pest or disease within the period prescribed, it shall be lawful for the Commission to take all necessary steps and to deal with such pest or disease: the cost attending the steps taken by such Commission shall in the first instance be paid out of the public revenue, and shall be recovered from such owner or occupier in any court of competent jurisdiction.

7. Notwithstanding the provisions of the preceding section set forth, it shall be lawful for the owner or occupier of the place or property on which the pest or disease exists, before the Commission commences to take steps for destruction or disinfection, but not otherwise, to notify to the Commission his intention to appeal direct to the Minister against the decision of the Commission, and to appeal accordingly: and upon receipt of his notification the Commission shall abstain from taking any further action until their recommendations have been approved, modified or disallowed by the Minister, and the decision of the Minister in the case shall be accepted as final: provided that if the owner or occupier does not file his appeal within one week from the date of his notification to the Commission, it shall be lawful for the Commission to proceed with the eradication and cure as if such notification had not been made.

8. Notwithstanding anything contained in the preceding sections, it shall be lawful for the Minister, whenever he has reason to believe that any specially dangerous plant pest or disease exists in any district or ward of a district, to inspect or direct the inspection of any property or place in which the pest or disease is alleged to exist and to take such steps as he may deem necessary for the suppression of such pest or disease.

9. It shall be lawful for the Governor upon petition made to the Minister by any such Horticultural Commission to declare by Proclamation in the *Gazette* any property, store, shed, room, or other place in any such district or ward for which such Commission has been appointed to be an infected area for the purposes of this Act, and by such Proclamation to prohibit the removal from any such area of any trees or plants, soil, boxes, packages or other material or articles suspected of being infected and liable to convey the pest or disease by reason of the existence of which such area is declared to be so infected.

10. It shall be lawful for any such Commission or any person duly authorised by such Commission to enter upon any lands and to do thereon such acts, matters and things as are necessary or reasonably required for carrying out the provisions of this Act: and it shall be lawful for such Commission to call upon any owner or occupier, if necessary for the eradication or cure of any pest or disease, to destroy any infected trees or plants and to disinfect the soil or place in which such trees or

plants have been growing or deposited, or to cause the same to be done; and any person obstructing, resisting or interfering with any such Commission or with any person duly authorised by such Commission, shall be deemed to be guilty of contravening the provisions of this Act.

11. Every person contravening any of the provisions of this Act or any Proclamation issued thereunder, shall be liable to the penalty specially prescribed for such contravention, and where no such penalty has been specially prescribed to a fine not exceeding £ , or in default of payment to imprisonment, with or without hard labour, for any period not exceeding....months, unless such fine be sooner paid.

12. From and after the date of the promulgation of this Act, it shall not be lawful for any person to sell or cause to be sold on any public market in the Colony or to transport or cause to be transported by any public conveyance any pest-infested or diseased fruit. Any person contravening or causing to be contravened the provisions of this section shall be liable upon conviction to a fine not exceeding £....., or in default of payment to inprisonment, with or without hard labour, for any period not exceeding.....months, unless such fine be sooner paid.

13. This Act may be cited as "The Plant Pest and Diseases Act, 1899."

APPENDIX C.—Import Regulations.

Draft of schedule recommended by Board of Horticulture of Western Province April, 1900.

1. The importation of the following articles is hereby prohibited:—

(*a*) Grape vines or any portion of fruit of any grape vine, with the exception of vines or portions thereof imported by the Government under such precautionary measures as it may deem necessary.

(*b*) Coffee plants or any portion thereof, with the exception of seed.

(*c*) Stone-fruit trees or any portion thereof, including seeds, that were grown or produced in any state, province or territory of the United States of America or the Dominion of Canada in which either of the diseases known as Peach Yellows or Peach Rosette exists.

(*d*) From and after the 1st March, 1901, the importation of peach stocks and peach stones from any country whatsoever shall also be prohibited.

2. The importation of any fruit tree or portion thereof, with the exception of fruit and seed, seedling stocks for budding or grafting purposes and blight-proof stocks for apples excepted, shall be permitted only under the following conditions:—

(*a*) A special permit must, previous to importation, be obtained from the Department of Agriculture, in which is stated fully the number and description of trees it is desired to introduce and from what locality and from whom they are to be procured.

(*b*) No one shall be allowed to import more than ten trees or separate parts of trees of any one variety or more than a total of one hundred trees or parts of trees during one year.

(*c*) Importation shall be restricted to varieties not catalogued by and procurable at a reasonable rate from any Colonial nurseryman.

(*d*) In the case of rooted trees, such articles must be accompanied by a sworn declaration from the consignor that they were carefully examined at the time of packing and found entirely free from boring insects.

(*e*) In the case of stone-fruit trees or portions or seed thereof, such articles must also be accompanied by a sworn declaration from the consignor that they were not grown nor produced from seed grown nor packed in any state, province or territory of the United States of America or Dominion of Canada in which either Peach Yellows or Peach Rosette exists.

3. All trees and plants and portions thereof, such as cuttings, roots, tubers and bulbs, and fruit of all kinds, and their packages, cases, pots or other coverings, shall, before being introduced into this Colony, undergo an examination by an officer appointed for that purpose to determine as far as possible whether or not insects

or plant diseases are present: and it shall be the duty of the consignee or his duly appointed agent, to open the coverings and to afford every facility to the Examining Officer during the examination.

4. Should any of the articles defined in the preceding clause be found on examination to be infected in whole or in part with any insect or plant disease whose introduction would be prejudicial to the interests of the Colony, they shall, together with their covering and packing material, be cleansed or disinfected by the consignee, or at his expense, in the manner prescribed by and to the satisfaction of the Examining Officer: and if not so cleansed or disinfected, or if the treatment shall be deemed or found to be ineffectual to eradicate the insect or disease, the articles shall be destroyed without delay.

5. All trees and portions thereof, together with their coverings and packing material, shall, whether or not any insect or plant disease is discovered in the examination provided for in Clause 3, be fumigated at the expense of the consignee in the manner prescribed by and to the satisfaction of the Examining Officer.

6. On the aforesaid Examining Officer being satisfied with respect to a consignment that all the regulations and conditions herein set forth, have been fully complied with, he shall issue a certificate to that effect to the consignee: and before the issue of such certificate, the landing or attempted landing of such consignment shall constitute a violation of these regulations.

7. Articles subject to examination under these regulations, introduced into this Colony by post, shall be intercepted and examined by an officer appointed for the purpose; and, if found infested with any noxious insect or plant disease, shall be destroyed or cleansed at the discretion of such Examining Officer and if requiring fumigation shall be so treated. All expenses of treatment shall be borne by the addressee.

8. The Government does not hold itself responsible for any loss or damage that may result from the destruction of articles under these regulations, or from any process that may be considered necessary to cleanse or disinfect the articles, or to discover the existence or otherwise of any insect or plant disease.

9. These regulations shall not apply to canned, dried or otherwise preserved articles, in which there is no longer any plant life.

APPENDIX D.

Temperature Records of Tick Infested Goats.

Explanation:—x signifies application of Red Tick; xx, application of Bont Tick; ——, inoculation with virulent blood; ═══, death of animal. Figures in black type denote fever period.

Date.	I.		II.		III.		IV.		V.		VI.	
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
April 6	x	..	x	..	x	..	x	..	..	xx	xx	..
7	..	..	..	..	..	..	..	..	..	..	..	..
8	..	..	..	..	..	..	..	..	..	..	..	..
9	..	..	..	..	..	..	..	..	..	..	..	..
10	103·2	104·0	102·6	103·4	102·0	103·4	103·0	104·0	102·0	102·8	101·6	102·2
11	103·0	103·7	101·9	103·8	103·1	103·9	102·6	104·1	101·2	103·0	101·2	103·6
12	102·2	103·2	104·0	104·2	103·0	104·1	103·4	103·8	102·3	103·4	101 9	103·2
13	101·8	102·8	103·8	104·3	102·4	103·8	103·6	103·9	102·6	103·7	102·5	103·6
14	101·8	103·4	103·7	104·8	103·0	103·7	104·3	104·1	102·9	103·9	103·5	104·0
15	102·7	102·2	104·4	103·9	103·3	102 0	103·4	103·9	102·8	103·2	102·8	103·8
16	102·4	102·4	104·0	104·6	102·4	103·1	103·5	103·2	103·0	103·8	102·0	103·6
17	101·8	103·2	103·6	104·3	101·5	103·7	103·3	104·3	102·3	103·8	102·2	104·4
18	103·0	104·0	104·3	104·9	102·1	103·7	103·2	104·3	102 2	103·8	103·5	103·1
19	103·8	105·1	105·5	106·2	103·4	105·0	103·0	104·4	103·8	104·8	**104·3**	**105·2**
20	103·9	104·2	105·6	106·0	104·0	103·7	103·9	104·2	103 9	103·5	**104·6**	**106·2**
21	103·4	104·8	104·6	104·6	102·5	104·3	104·1	104·5	**104·5**	**104·8**	**106·0**	**105·3**
22	103·7	103·7	103·8	104·4	102·6	102·7	104·6	104·7	**104·4**	**105 8**	**106·9**	**107·9**
23	103·0	104·2	104·0	105·5	101·8	102·8	103·4	104·0	**105·8**	**106·3**	**107 7**	**108·2**
24	102·9	103·6	103·4	104·7	102·0	103·0	103·7	103·8	**106·4**	**106 4**	**107·0**	**107·0**
25	103·6	103·6	103·3	104·4	101·7	102·0	103·4	104·6	**106·6**	**106·5**	**105·7**	**106·0**
26	101·7	103·1	103·0	103·5	100·4	101·0	102·9	102·6	**105·4**	**105·8**	**103·8**	**103·8**
27	102·1	103·3	102·0	104·2	103·4	103·7	102·4	104·3	**104·2**	**104·6**	102·8	103·4
28	103·0	104·0	103·3	104·0	103·0	104·1	102·8	104·2	**104·0**	**104·0**	102·8	103·6
29	103·5	106·0	103·0	105·2	101·3	104·0	102·4	103·2	101·9	103·3	102·0	103·1
30	106·6	107·0	104·3	104·3	101·2	102·2	102·8	103·2	102·7	104·5	102.7	103·8
May 1	105·7	106·5	103·5	104·7	101·1	102·8	103·2	103·4	103·6	105·8	102·7	103·1
2	105·8	106·1	103·7	104·6	100·6	102·6	103·4	104·5	104·9	105·2	101·9	102·5
3	103·3	104·4	103·2	104·0	101·0	100·5	103·8	103·8	104·5	105·8	101·2	103·1
4	101·5	102·0	103·1	103·9	100·5	102·3	103·8	104·3	103·6	104·7	100·7	102·6
5	101·0	103·0	103·5	102·0	101·8	**104·5**	104·4	104·7	102·5	103 3	102·8	103·9
6	102·0	**105·6**	103·6	104·5	**104·0**	**106·6**	104·1	104·6	101·0	102·6	101·5	103·8
7	..	═══	102·3	103·8	**107·3**	**107·3**	103·2	104·2	100·7	101·8	101·9	103·4
8	..	..	102·8	105·4	═══	..	103·9	103·9	100·6	101·8	101·8	103 8
9	..	..	103·8	103·2	..	..	101·5	103·1	100·5	101 2	101·5	102·8
10	..	..	103·3	102·4	..	..	102·4	103·3	101·4	101·6	102·1	102·0
11	..	..	102·2	103·8	..	..	101·9	103·4	101·0	102·1	100·7	101·8
12	..	..	103·8	104·1	..	..	102·5	103·6	101·7	102·1	101·7	102·4
13	..	..	102·2	104·2	..	..	102·9	103.4	102·0	102·3	102·5	103·0
14	..	..	103·1	103·7	..	..	103·1	103·2	101·2	101·9	102·1	102·3
15	..	..	103·1	104·3	..	..	102·4	103·0	103·0	102·8	102·3	103·2
16	..	..	102·7	103·9	..	..	102·3	103·3	101·4	102·5	102·4	102·0
17	..	..	103·7	103·3	..	..	104·1	103·2	100·7	101 9	101·5	102·5
18	..	..	103·4	103·6	..	..	104·0	103·7	102·3	102·5	103·0	102·7
19	..	..	102·9	102·0	..	..	103·4	103·0	102·6	101·7	102·2	102·0
20	..	..	103·2	102·3	..	..	102·7	103·8	102·5	100·9	101·4	100·3
21	..	..	101·9	..	..	..	102·5	..	100·8	..	100·3	..
22	..	..	102·8	103·7	..	..	103·6	103·5	101·4	102·5	101·4	102·0
23	..	..	103·0	104·0	..	..	103·7	104·7	101·5	102·1	100 0	102·4
24	..	..	103·0	..	..	..	104·0	..	101·3	..	101·7	..
25	..	..	102·8	103·0	..	..	104·5	103·2	102·5	102·6	102·4	102·9
26	..	..	102·6	102·4	..	..	105·6	104·7	102·6	103·0	101·0	103·0
27	..	..	102·7	102·4	..	..	102·6	103·1	101·5	102·5	100·6	102·5
28	..	..	102·8	..	..	..	101·4	..	101·6	..	99·8	..
29	..	..	102·6	104·0	..	..	102·0	103·7	101·9	102·5	100·7	102·6
30	..	..	101·7	103·2	..	..	102·4	102·1	102·6	103·7	101·9	100·5
31	..	..	101·4	103·7	..	..	101·2	103·0	103·0	102·8	101·8	102·9
June 1	..	..	103·0	103·0	..	..	102·6	103·2	101·6	103·8	101·4	102·8
2	..	..	102·5	103·5	..	..	102·0	102·3	101·9	103·8	102·4	102·7
3	..	..	103·8	102·3	..	..	102·1	101·8	102·8	103·8	101·5	102·5
4	..	..	103·7	104·0	.	..	102·5	103·6	102·4	103·8	102·0	103·2

Date.	VII.		VIII.		IX.		X.		XI.		XII.	
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
April 6	..	..	..	..	..	..	..	..	..	..	..	..
7	xx	..	..	..	..	..	..	..	..	..	..	..
8	..	..	..	..	..	..	..	..	..	..	..	..
9	..	..	..	..	..	..	..	..	..	..	..	..
10	101·6	102·2	xx	103·0	..	..	..	..	..	..	..	..
11	101·8	104·2	101·0	103·4	..	..	..	.	..	..	..	..
12	101·0	103·3	102·8	103 7	..	..	..	..	..	..	..	..
13	102·3	103·8	102·5	103·6	..	..	..	..	..	..	..	..
14	102·2	104·3	102·6	103·7	..	..	..	..	..	..	..	..
15	102·5	103·4	103·0	104·9	..	..	..	..	..	..	..	..
16	103·5	103·1	102·6	103·3	..	..	..	..	..	..	..	..
17	102·0	103·3	102·6	104·0	..	..	..	..	..	..	..	..
18	102·0	104·0	104·1	104·8	..	..	..	..	..	..	..	..
19	102·6	104·9	104·9	105·6	..	..	..	..	..	..	..	..
20	103·7	104·3	103·9	104·6	..	xx	..	..	..	..	..	..
21	104·5	106·4	102·7	104·2	101·2	102·4	xx	102·5	..	..	..	..
22	106·5	107·6	103.0	104 0	101·6	102·7	101.9	102·9	..	..	..	..
23	106·6	107·6	105 3	106·7	102·8	102·8	102 0	102·8	..	..	..	..
24	107 7	107·2	106·7	106·8	102·1	102·4	102·5	103 0	..	..	..	..
25	107·0	106·2	107·3	107·2	102·3	101 7	101·8	102 3	..	..	..	..
26	106·0	105·4	107·0	107·3	101·5	102·8	101·7	102·3	..	..	..	..
27	104·7	104·0	106 9	106 6	102·8	103·0	101·9	102·1	..	..	..	..
28	102·6	103.4	106·0	105·6	102·6	102·5	102·8	102·9	..	..	..	..
29	101·6		104·3	104·6	103·0	103·0	102 6	103 7	..	..	..	..
30	.	..	102·2	103·9	102·4	104·0	103·2	104·3	..	..	..	..
May 1	..	..		..	103·8	105·1	103·0	102·9	..	..	..	..
2	..	..	..	..	105·0	104·8	102·3	103·8	..	102·3	..	..
3	..	..	..	..	105·7	106 5	102·9	104·5	101·7	103.0	..	..
4	..	..	..	..	104 2	104·5	103·0	102·4	101·7	102·5	..	..
5	..	..	..	..	104·1	103·5	102·9	104·3	101·7	102·5	..	..
6	..	..	..	..	102·3	102·1	105·2	105·6	102.2	102·2	..	..
7	..	..	..	..	101·8	102·2	105·6	106·2	101·4	102·4	..	..
8	..	..	..	..	102·0	102·2	106·2	107·2	101·8	103·0	..	..
9	..	..	..	..	101·8	101·5	107·6	107·7	101·5	102·0	..	..
10	..	..	..	..	101·9	102·3	107·2	107·0	101·9	102·1	..	..
11	..	..	..	..	102·2	102·6	106 2	106·7	101·5	101·9	..	..
12	..	..	..	..	102·0	102·0	105·7	106·0	100·4	101·8	101·8	103·6
13	..	..	..	..	102·0	101·6	105·7	105·4	101·0	101·4	102·0	102·6
14	..	..	..	..	102·7	103·4	104·4	103·5	101.2	102·1	100·0	102·3
15	..	..	..	..	103·0	103·7	103 1	103·2	102·4	103·0	102·5	104·3
16	..	..	..	..	102·7	103·1	102·7	102·6	100·9	102·0	101·8	100·3
17	..	..	..	..	103·4	103·3	102·9	102·1	101·8	101·9	101·0	100·7
18	..	..	..	..	103·0	103·0	103·4	103·5	102·4	100·0	101·4	102·0
19	..	..	..	..	103·1	103·2	103·7	102·7	102·3	102·0	101·8	102·6
20	..	..	..	..	101·1	102.4	100·4	102·2	102·0	101·7	101·6	103·2
21	..	..	..	..	102·6	..	102·0	..	101·1	..	104·6	106·1
22	..	..	..	..	103·2	102·8	102·3	101·3	100·3	101·8	106·0	105·0
23	..	..	..	..	102·7	104·0	102 2	102.5	100·6	102·7	102·7	104·0
24	..	..	..	..	104·0	..	102·4	..	100·8	..	103·1	..
25	..	..	..	..	103·2	103·0	102·4	102·6	101·4	102·0	101·8	102·3
26	..	..	..	..	103·5	103 0	102·1	102·1	101·5	102·5	102·0	103·0
27	..	..	..	..	102·8	104·0	102·2	102·3	100·3	102·6	102·7	103·0
28	..	..	..	..	103·0	..	102·9	..	99·8	..	101·6	..
29	..	..	..	..	102·7	104·2	101·8	102·4	100·8	103·6	101·7	102·6
30	..	..	..	..	103·0	103·6	102·0	102·2	101·6	101·7	101·8	102·6
31	..	..	..	..	102·6	103·5	102·0	102·8	101·3	102·9	101·7	102·9
June 1	..	..	..	..	102·6	103·6	100·5	103·0	100·0	102·9	100·0	104·6
2	..	..	..	..	102·6	102 8	102·2	102·0	101·4	102·6	102·4	103·0
3	..	..	..	..	102·1	102·5	102·6	103·7	101·4	103·1	102·4	102·2
4	..	..	..	..	103·5	103·7	103·0	103·3	102·0	103·0	102·3	104·1
5	..	..	..	..	102·8	..	102·8	..	101·6	..	103·3	..

INDEX.

A.

Acanthia lectularia, in gaols .. 7
Acræa horta, fungus disease of .. 33
Acridium purpuriferum, notes on .. 54
Adalia bipunctata, attempted introduction of 30
flavomaculata, sent to Ascension 6
Amblyomma devium on quail and goat 19
hebræum. (See Bont Tick)
Anaheim disease, reference to report on 23
Aphides, need of natural enemies of 27
Aphis persicæ-niger on imported trees 9
Aspidiotus aurantii, see Red Scale 23, 25, 26
citrinus in California 25
perniciosus on imported trees .. 9

B.

Bacterial disease of ladybirds and caterpillars 32, 33
Beneficial insects, introduction of 4, 29, 34
Black Peach Aphis on imported trees 9
Black Scales, parasites sent to California 5
Bont Tick, in Tick-Heartwater experiment 2, 12-22
normally non-pathogenic .. 2
transmitter of heartwater 2, 17

C.

Ceratitis capitata. (See Fruit Fly) 47
Chilocorus bivulnerus, attempted introduction of .. 35, 37
distigma, mentioned 35
Chilomenes lunata, sent to Ascension 6
Coccinella 9-notata, attempted introduction of .. 29-33
sanguinea, attempted introduction of 30
transversoguttata, attempted introduction of .. 30, 32
Codling Moth, notes on 46
Colias electra, disease of 33
Cryptinglisia on grape roots .. 54
Cryptolæmus montrouzieri, introduction of ..4, 34, 36, 37, 53
Cucurbs, maggots in 47

D.

Dactylopius of grape vine .. 8, 53
pineapple, notes on 53
Dacus ferrugineus in cucurbs .. 48
Diamond Back Moth, fungus disease of 50
notes on 8, 50
success in spraying 51
Diaspis amygdali, in Oudtshoorn .. 40
rosæ, on imported trees .. 10

E.

Entomophthora aphidis, destroying aphides 32, 52
Eriocampoides limacina, egg parasite of 39
Eriococcus araucariæ, eaten by Cryptolæmus 36

F.

Fruit Fly, notes on 47
similar insect in blackberries .. 47
similar insect in Natal .. 47
Fruit growers, resolution regarding beneficial insects 22
indifference to pest legislation 40
Fumigation in gaols 7
of orchards 7
Fungus disease of aphides .. 32, 52
of Diamond Back Moth .. 50
of Red Scale 26

G.

Gaols, fumigation to destroy vermin 7
Grain Bug, notes on.. 49
Granary insects, experiments to destroy 8
Grape, mealy bug of 53
root scale insect of 54
Grapes, Loquat Worm in 51

H.

Heartwater. (See also Tick-Heartwater)
communicable by blood inoculation 2
communicated by ticks 2, 17, 21
not contagious 21
not contracted with food or drink .. ..
possibility of eradicating ..
ticks thought by farmers to transmit 2
variations in intensity of fever 18
Heliothis armiger, disease of .. 33
notes on 50
Hippodamia convergens, enemy of Woolly Aphis 34
glacialis, attempted introduction of 30, 32
parenthesis, attempted introduction of 29
13-punctata, attempted introduction of 30
Hydrocyanic acid, gaol fumigation 7
orchard fumigation 7
useless in treating stored grain 8

I.

Import regulations, discussion of 44-46
proposed schedule 59
Insect legislation, discussion of 39-46
in California 43

J.

Japanese Plums, attacked by Natal Fruit Fly 47

L.

Ladybird, native, on mealy bugs .. 53
Ladybirds, bacterial disease of 32, 33
importation of 6, 29, 34
relations with aphides 27
sent to Ascension 6
Lecanium oleæ. (See Black Scale.) 5
Legislation, insect, discussion of 39-46
in California 43
Lita solanella, in imported potatoes 10
Locusts, fungus inadequate as remedy for 55
need of legislation 55
notes on 54
Loquat Worm, notes on 54

M.

Mealy bug, of grape vine, note on 53
pineapple, note on 53
Mealy bugs, eaten by Cryptolæmus 36
Megilla maculata, attempted introduction of 29
Melons, maggots in 47, 48
Mytilaspis pomorum, on imported trees 9

N.

Napthalin, useless for insects in grain 8
Nectarophora pisi, on peas .. 27, 51
disease of 32, 52
Novius bellus, introduction of 34, 37
cardinalis. (See Vedalia) 6, 35
kœbeli, attempted introduction of 35
sp. (black), attempted introduction of 34, 37
Nurseries Bill, discussion of 39-41
draft of 56
Nysius augustatus, reference to .. 49

O.

Oenopia cinctella, sent to Ascension 6
Ophiuza lienardi, injuries to fruit .. 48
Orange Worm, notes on 49
Orchard Pest Bill, discussion of .. 41
draft of 57
Orcus australasiæ in California .. 24
chalybeus in California .. 24
Orthezia insignis, out-doors near Capetown 52
Oyster Shell Bark Louse, on imported trees 9

P.

Pachytylus capensis, nete on .. 54
Pea Aphis, its enemies 27
notes on 51, 52
Pear Slug, egg parasite of 39
Pentilia misella, attempted introduction of 5, 37
Plant Pests and Diseases Bill, discussion of 41-43
draft of 57
Plums, Japanese, attacked by Natal Fruit Fly 47
Plutella cruciferarum. (See Diamond Back Moth) 8, 50
Potato Tuber Moth, in imported potatoes 10
Publications, during year reviewed 10

R.

Red Scale, destructiveness in Australia 25
discussion on enemies of 23-27
fungus disease of 26
Southern Europe as home of .. 25
Red Tick, in Tick-Heartwater experiment 12-22
possible transmitter of mild heart water 18-21
Rhizobius lophanthæ, attempted introduction of .. 35, 37
ventralis, attempted introduction of 35, 37
Risper. (See Heliothis armiger) 8, 33, 50

S.

San Jose Scale, on imported trees .. 9
Scutellista cyanea, exported to California 6
Sphærostilbe coccophila, fungus of Red Scale 26
Sphingomorpha monteironis, injuries to fruit 48

T.

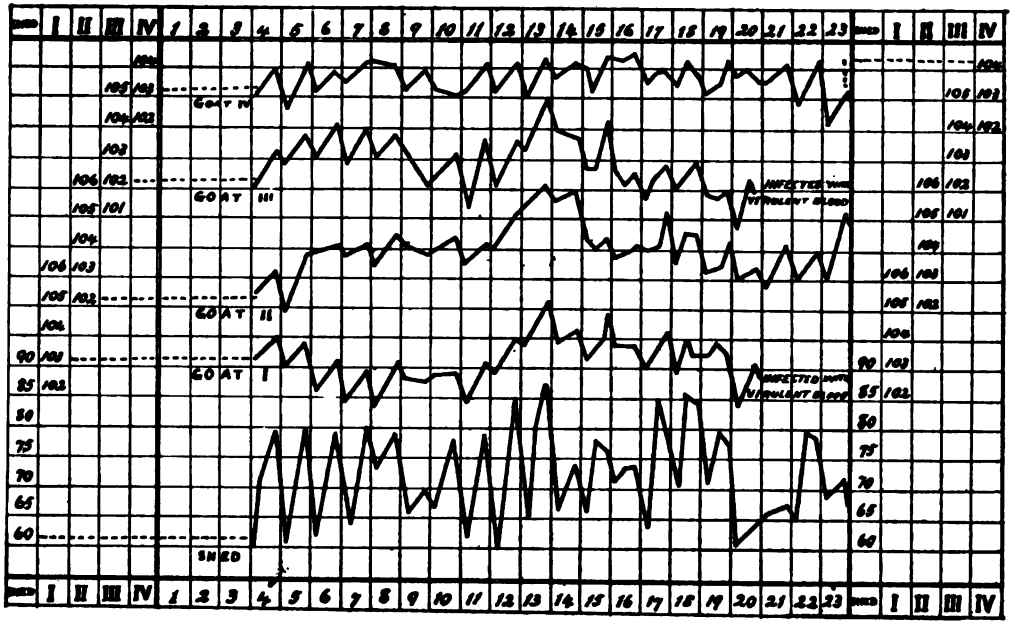
Tick, Bont, in Tick-Heartwater experiments 2-4, 12-22
normally non-pathogenic .. 2
transmitter of heart-water 2, 17
Red, in Tick-Heartwater experiments 12-22
doubtfully a transmitter of mild heartwater 18-21
Tick-Heartwater experiment, detailed account of .. 12-22
infection of ticks for 13
plan of 12
recovery of ticks in 15
results of 21
investigations, general account of 2-4
Tortoise ticks, on quail and goat .. 19
Trypeta penicellata, reference to .. 47
Trypetid flies. (See Fruit Fly) .. 47

V.

Vedalia, distribution of colonies .. 6
from California 35
Vermin in gaols, destruction of .. 7
Vine, mealy bug on 53
scale insect on root of 54

Y.

Yellow Scale, suppressed by parasite 25



Temperature Chart of the Goats infested with Red Ticks *(Rhipicephalus evertsi)* from Heartwater diseased Animals, from the Date of the Application of the Specimens through the crucial Period. The Animals remained healthy throughout.

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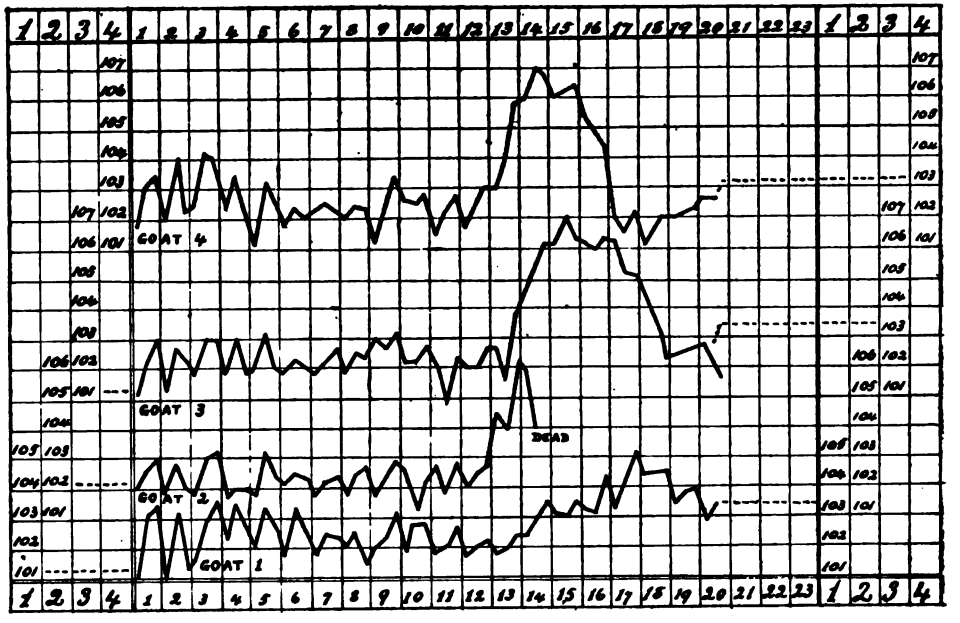
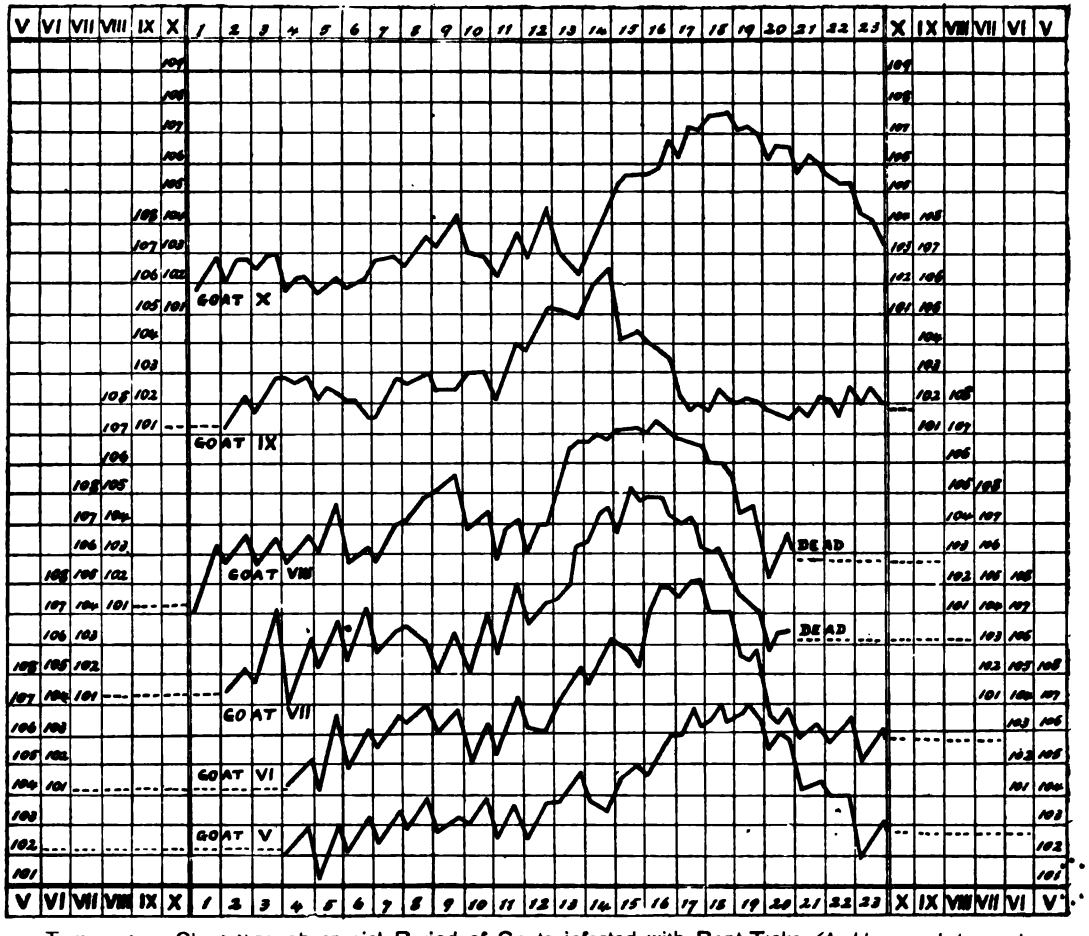


Temperature Chart through the crucial Period of Goats in Heartwater Experiment infected by Inoculation with virulent Blood. The Ticks used on Goats I to X were taken from these Goats during the fever stage.

Withdrawn



Temperature Chart through crucial Period of Goats infested with Bont Ticks *(Amblyomma hebræum)*.
Every Animal contracted the Heartwater Fever.

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PLATE IV.

Goat dressed for Recovery of Ticks from Udder and Belly, Feet, Ears, and Tail.

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Goat dressed for Recovery of Ticks. This Type of Dress, with addition of Ear Caps when young Red Ticks were on, has been used in all the later experiments.

Interior of one of the Experiment Sheds, showing a Goat in its Stanchion, with open Stanchion to left and a closed one to right.

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CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

YEAR 1900.

Presented to both Houses of Parliament by Command of His Excellency the Governor.
1901.

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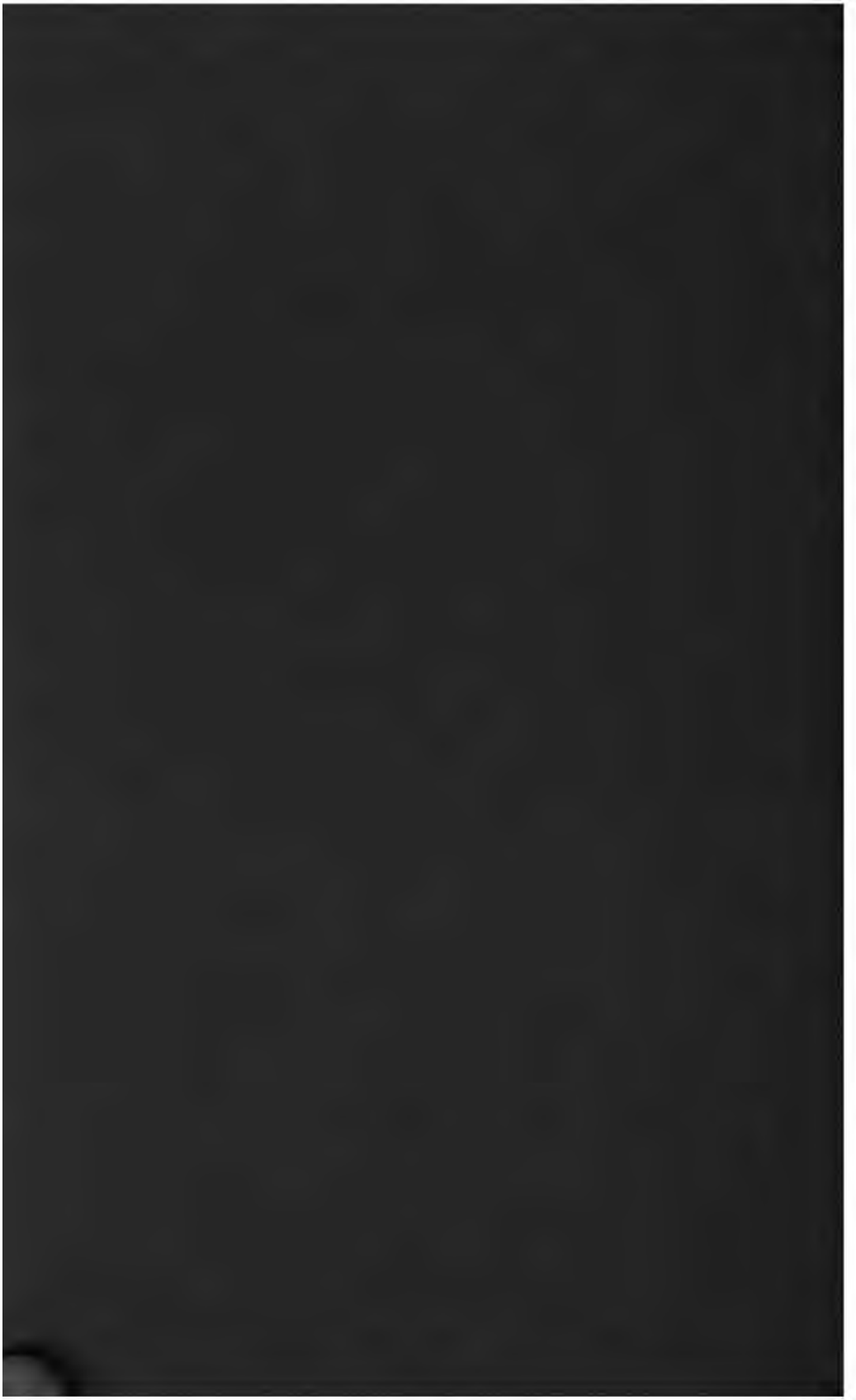

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1902.

[G. 29—1902.] A.2685.1250.6.02.

Cape Town, 17th May, 1902.

THE HONOURABLE THE SECRETARY FOR AGRICULTURE.

SIR,—I have the honour to present herewith my report for the year 1901.

CHAS. P. LOUNSBURY, B.Sc., F.E.S.,
Government Entomologist.

TABLE OF CONTENTS.

Letter of Submittal. PAGE

SECTION I.—GENERAL REPORT.

General Statement 1
Correspondence and Publications 2
Tick-Heartwater Investigations 3
Tick-Malignant Jaundice Investigations 4
Proved Transmission of this Disease by a Tick.
Adult stage of the Tick only concerned.
Possibly analogous Case of Redwater Transmission.

Natural Checks for Insect Pests 9
Cryptolæmus montrouzieri. 9
Introduction and Distribution.

Red Scale Fungus 12
Experiments with artificial Cultures.

Exochomus pilatei Ladybird from California 13
Chilocorus bivulnerus Ladybird from California 14
Megilla maculata Ladybird from Massachusetts 15
Hippodamia convergens Ladybird from California 16
Largest Ladybird Shipments ever made.

Chinese Red Scale Parasite 17
Promise of a Colony.

Distributions of Beneficial Insects 20
Lecanium oleæ Parasites to California.
Cochineal Insect to Ceylon.
Vedalia for Australian Bug Suppression.

Hydrocyanic Acid Gas Fumigation 22
Orchard Fumigation 22
Railway Coach Fumigation 23
Gaol Fumigation 23
Fumigation of Tokai and Kimberley Gaols.
Applicability of Remedy to Barracks, &c.

Experiments for the Plague Administration 24
Strength of Gas fatal to Vermin.

Experiments with Insecticides 25
Important Work with Lime-Sulphur-Salt 25
Disinfection of Vine Cuttings 26
Hot Water Treatment.
Carbon Bisulphide Fumigation.
Experiments with Bisulphide and Hydrocyanic Acid Gas.

PAGE

SECTION II.—SPECIAL REPORTS

TICK-HEARTWATER INVESTIGATIONS 29

Part I.—Descriptive and Historical

What Heartwater is 29
Presumed organismal character.
Symptoms.
Post-mortem appearances.

History of Heartwater 32
Appearance and spread of the disease.

Animals subject to Heartwater 35
Calves may not be immune.

Severity of Heartwater 36
Variations in virulence.

Losses from Heartwater 38
Small stock statistics.

History of the Bont Tick 39
Known for sixty years.

Heartwater Introduction Theory 41
Suggestion that disease came from the North.

Co-operation with Veterinary Branch 43
How the investigations began.

Stable Accommodation for Experiments 45
Animals for the Experiments 45

Application and Recovery of the Ticks 47
Description of clothes used on animals.

Temperature of Animals 49

Part II.—Experiments 50

Experiments resulting positively.
A. Infection transmitted by Nymphs fed as Larvæ on sick Animals.
B. Infection transmitted by Adults fed as Nymphs on sick Animals.
C. Infection transmitted by Nymphs fed as Larvæ on recently recovered Animals.
D. Infection transmitted by Adults fed on Cow as Nymphs, but on sick Animals as Larvæ.
E. Infection transmitted by Adults fed on long recovered Goat as Nymphs, but on sick Animals as Larvæ.
F. Infection transmitted to recovered Animals by pathogenic Nymphs.

Experiments resulting negatively 56
L. The Bont Tick is normally Non-pathogenic.
M. The Progeny of Pathogenic Bont Ticks appear non-infective.
N. Bont Ticks from long recovered Animals either transmit only very mild Infection or none at all.
O. Bont Ticks dropped during most of the Incubation Period are harmless.
P. Bont Tick Males transferred from a sick to a susceptible Animal seem innocuous.
Q. Red Ticks are Non-Pathogenic.
R. Blue Ticks are Non-Pathogenic.
S. The Tampan does not transmit Infection.

PAGE

Summary of Results 66

Life Cycle and Habits of the Bont Tick 63
Description of different stages.
Duration of stages on the host.
Duration of stages off the host.

Deductions from the Knowledge gained 69
Cattle the best host for the Bont Tick.
Dangers of introducing the disease
Possibility of eliminating infection from Veld.

THE TREATMENT OF BUILDINGS WITH HYDROCYANIC ACID GAS FOR THE DESTRUCTION OF VERMIN 74

Applicability of Treatment 75
Not of Use for Insects in stored Grain
May be done at any Season.

Chemicals required 77
Proportions in which used.

Generating Vessels 79
Utility of various Kinds.

Charges for given Space 79
Very large single Charges inadvisable.
Little Danger of exploding Gas.

Procedure of Operations 80
One Man should be responsible.
Multiple Discharges.
Alternative Procedure.
Period of Exposure.

Ventilation 83
Time necessary.
The most responsible Time for the Operator.

The Refuse 84
Incomplete Reactions.

Fumigation a supplementary Measure 84
Where most useful and best justified.

Recapitulation 85

EXPERIMENTS WITH INSECTICIDES 88

Lime-Sulphur-Salt Wash.
Previous Doubt as to its Action on Insects
Conditions of Tests.
Preparation of the Wash.
Enumeration of Tests.
Lime-Sulphur, Lime-Salt, and Lime only also used.
Chemical Analysis of Lime-Sulphur Solutions.
Subsequent Rain-fall and Notes on the Tests.
Results on the Insects.
Lime-Sulphur seemingly as efficient as Lime-Sulphur-Salt.

Resin Wash. 95
Preparation of the Wash.
Experiments with Red Scale.
Experiments with White Peach Scale.
Experiments with Woolly Aphis.

PAGE

Soap Washes 98
Whale Oil Soap for Scale and Aphis.
Soft Soap and Hard Soaps.

Paraffine Emulsion 100
Details of Preparation.
Tests with Red Scale, White Peach Scale, and Woolly Aphis.

Mechanical Mixture of Paraffine and Water 101
Tests with Scales and Aphis.

Cyanide of Potassium in Water Solution 102
Unsatisfactory against Scale.

Summary .. ..
Opinions on Value of various Washes tested.

INDEX.

A.

Acanthia lectularia, fumigation remedy for 74-88
Amblyomma devium, mention .. 69
eburneum, mention .. 40
hebræum, see Bont Tick.
American Blight, see Woolly Aphis.
Argas persicus, resistant to cyanide gas 75
Aspidiotophagus citrinus, scale parasite 20
Aspidiotus aurantii, see Red Scale.
citrinus, mention .. 19
perniciosus, fungus of .. 12
Aulacaspis bromeliæ, parasite of 20

B.

Bed-bug, fumigation remedy for 74-88
experiments in destroying 24
in gaols, etc. .. 23
Blue Tick, not associated with heartwater 3,57,64
Bont Leg or Bontepooten Tick, failure to rear .. 69
Bont Tick, and heartwater 8,50-74
history of 39
on eland 40
on wildebonde .. 40
only transmitter of heartwater 2
Boophilus bovis, mention .. 57
Bush bucks and heartwater .. 39

C.

Calves and heartwater .. 36
Carbon bisulphide and vine cuttings 27
Chemicals for cyanide gas generation, .. 77
Chilocorus bivulnerus, introduction of 14
Chinese Red Scale parasite .. 17
Chionaspis braziliensis, parasitized 20
Cochineal insect, sendings to Ceylon 21
Correspondence of office .. 2
Cryptolæmus montrouzieri, introduction of 9

D.

Diaspis pentagona, see White Peach Scale.
Dog Flea, not associated with malignant jaundice 8
eggs destroyed by cyanide gas .. 75
Tick, determination of .. 5
life cycle of .. 5
transmitter of malignant jaundice .. 5

E.

Ectobia germanica, eggs destroyed by cyanide gas .. 75
Eriococcus araucariæ, new ladybird enemy of .. 11
Exochomus nigromaculata on Woolly Aphis .. 98
pilatei, introduction of 13

F.

Fleas and cyanide fumigation .. 75
not associated with malignant jaundice 8
Flies and cyanide fumigation .. 75
Fowl Tick, resistance to cyanide gas 75
Fumigation of buildings .. 74-87
procedure of 80
ventilation 83

G.

Gaols, fumigation 23

H.

Hæmaphysalis leachi, see Dog Tick.
Heartwater, investigations .. 2-4 29-74
animals attacked .. 35
character of malady .. 29
experiments 50-66
history 32
introduction theory .. 41
losses from 38
means of preventing .. 71
severity of 36
Hippodamia convergens, introduction of 16
Homalotylus sp., ladybird parasite 12
Hyalomma ægyptium, failure to rear 69
Hydrocyanic acid gas fumigation 22
application in buildings .. 74-87
gaol treatment .. 23
orchard treatment .. 22
railway carriage treatment 23
vine cutting treatment .. 27

I.

Ixodes poortmani, same as Bont Tick 40

K.

Kimberley gaol fumigation .. 23

L.

Ladybird introductions ..9,13,17
Lecanium oleæ, parasite of .. 20
Lime as insecticide .. 91-95
Lime-salt as insecticide .. 91-95

Lime-sulphur wash, analyses .. 91
efficacy against scale.. 93
Lime-sulphur-salt wash, discoveries in regard to .. 25
efficacy against White Peach Scale .. 93
expense of .. 95
experiments with .. 89-95

M.

Mealy Bug, new ladybird enemy of 11
Megilla maculata, introduction of 15
Myoporum insulare, Lecanium olese on .. 20

O.

Oleander, Lecanium olese on .. 20
Onithodoros savignyi, failure to transmit heartwater 65

P.

Plague bacillus, exposed to fumigation .. 25
Phylloxera on vine cuttings .. 24
Potassium cyanide, see hydrocyanic acid gas ..
in water solution as tree wash .. 102
Publications of office .. 2

R.

Resin wash, against Red Scale 96
White Peach Scale 97
Woolly Aphis .. 97
preparation of .. 97
Red Scale, Chinese parasite of .. 17
cyanide in solution for 102
fungus disease of .. 12
paraffine and water for 101
paraffine emulsion for 100
resin wash for .. 96
soap washes for .. 98,99
winter killing of .. 89
Red Tick, not associated with heartwater 3,56,63
Rhipicephalus annulatus, referred to .. 57
decoloratus, see Blue Tick.
evertsi, see Red Tick.

S.

Schilpad Tick on goats .. 69
Schizoneura lanigera, see Woolly Aphis.
Scutellista cyanea, Lecanium olese parasite 20
Sphærostilbe coccophila, Red Scale fungus 12

T.

Tampan, not associated with heartwater .. 65
Tick-Heartwater investigations, general account .. 2-4
detailed account .. 29-74
Tick Malignant Jaundice investigations, general account 4-9
Ticks, clothes for catching . 49
need for washes to destroy 4
suggested eradication by starving out plan .. 3,71

V.

Vedalia, distribution of .. 23
Vine cuttings, disinfected by carbon bisulphide fumes .. 26
cyanide gas 27
hot water 26

W.

White Peach Scale, lime sulphur washes for .. 88–94
paraffine and water for .. 101
paraffine emulsion for .. 100
resin wash for .. 97
soap washes for .. 98-99
winter killing of .. 89
Woolly Aphis, paraffine and water for 102
paraffine emulsion for 100
soap washes for .. 99

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1901.

Presented to both Houses of Parliament by command of His Excellency the Governor.
1902.

GENERAL REPORT.

The plan of work followed for several years past was continued through 1901. In addition to the duties that have become routine, such as attention to enquiries concerning insects, the inspection of plant imports, the preparation of reports on entomological matters for the Department and of contributions for the *Agricultural Journal*, several special lines of enquiry and investigation have been kept continually in progress. Owing to the disturbed state of the country almost the whole of my time has been spent at Cape Town, and therefore much more actual research work has been accomplished and there is more matter on which to report than if, as in ordinary years, I had spent a quarter or a third of my time in journeying about the country. One learns a vast amount that can be turned to profitable account in country trips, and probably does a great deal of good by coming in personal contact with the people and instructing them by word of mouth, but such work yields little in result that is tangible at the time and which can find a place in a report.

The duties of the office have been ably shared by the Assistant Entomologist, Mr. C. W. Mally B.Sc., M.S. Under my supervision he has conducted several investigations and has done a considerable amount of field work. In a desire to do him full justice I have had him draw up reports on some experiments and am including these, under his name, among the appendices.

Correspondence and Publications.

The number of official letters received during the year was about six hundred and the number despatched somewhat above seven hundred. No account is taken of enquiries and applications necessitating only the despatch of printed matter in reply. Sixty-eight reports on various subjects, some of which demanded lengthy consideration, were made to the Department. A treatise on orchard fumigation, entitled "Cyanide Gas Remedy for Scale Insects," was prepared in the latter part of the year and has since been published. The contributions of original matter to the *Agricultural Journal* were as follows:—

TITLE.	Form.	Issue.	Pages.
Anaheim or California Vine Disease ..	Article	Jan. 17	Vol. xviii. 90-94
Tree Fumigation in California	..	Feb. 14	210-223
Scale on South African Fruit	Note.	May 9	716-718
Disease in Pineapples	Reports.	Aug. 1	Vol. xix. 171-180
Transmission of Malignant Jaundice of the Dog by a Species of Tick	Article.	Nov. 21	714-724
Bordeaux Mixture: "Soda Bordeaux" and "Bodo"	Article.	Dec. 5	781-789

Tick-Heartwater Investigation.

Experimental research to determine the relations, if any, that exist between the sheep and goat disease known as heartwater, and the various species of stock-infesting ticks that occur in the affected territory, has formed a very important part of the year's work, and has had the uninterrupted personal attention of the writer throughout the whole period. A number of important findings has been made. Thus far only one species of tick, the so-called Bont Tick (*Amblyomma hebræum*), has been found to be associated with the disease. A single specimen of this species if fed on a heartwater-sick animal as a larva or "seed" tick has been found capable of transmitting the malady with fatal effect. An animal pastured on veld heavily infested by the tick may drop hundreds and even

thousands of pathogenic larvæ during its period of illness, and thus may indirectly serve for the almost total extermination of a flock in a few months. The terrible mortality amongst healthy flocks, brought to the coast where the tick is abundant, is thus easily explained. Pathogenic larvæ have been found to retain their dangerous character until they are adult. They may take their second or nymphal feeding on an ox or a non-suspectible goat and then in the third or final stage get on to a susceptible sheep or goat and give it deadly fever. On the other hand, the disease appears to be non-transmissible through the egg stage, and the species is normally non-pathogenic in all stages. A farm may be badly infested with Bont Tick and yet be entirely free from heartwarter. The Red Tick (*Rhipicephalus evertsi*) and the Blue Tick (*Rhipicephalus decoloratus*) appear to take no part in the carriage of this disease.

Only the entomological phase of the heartwater problem, that is the association of ticks in transmitting the disease, is engaging my attention. Other phases have received, and to some extent are still receiving, the attention of the Veterinary Department, and of the Bacteriological Institute; but thus far the side of the question that to my mind is of the greatest economic importance has been left untouched. I refer to experiments to test the practicability of eradicating the disease and of keeping the tick suppressed. Everything that has been learned to date regarding the nature and spread of heartwater appears to me hopefully indicative that the disease is one which may be eliminated by the temporary exclusion of stock susceptible to it; and in the nature of things the tick may be almost, if not wholly, exterminated by the exclusion of all stock. I believe that two years would suffice to practically eradicate the tick from a well enclosed camp. The disease would, I expect, die out in less than eighteen months, and the ticks be very few in twelve months. Only by actual experiment can the feasibility of overcoming the disease on a farm by such starvation means be satisfactorily determined, and I respectfully suggest that it would be a wise act for the Government to get control of portions of a few notoriously bad heartwater farms in different districts, to securely enclose these, and to arrange with the owner and

police to occasionally patrol the fencing to see that it remains intact. Each enclosure might be sub-divided into paddocks and these paddocks be experimentally stocked in succession at the expiration of twelve, fifteen, eighteen, twenty-four and thirty months. The enormous losses due to ticks, apart from their connection with the disease, fully warrant the undertaking of such a series of experiments.

There is wanting, too, a more complete knowledge of the value of the various substances that may be applied to stock, by dipping or by spraying, for the direct destruction of ticks and for deterring their attack. The field is not a promising one and an experimenter might work diligently for four or five years and then have succeeded in finding no substance superior to those whose value we now know, yet the need of a cheap and efficient tick-destroyer and a tick-deterrent is so great that systematic endeavours should really be made to ascertain if they exist.

A detailed report on the progress of the experiments being conducted for the determination of the means by which heartwater is disseminated is given in Part II.

Tick-Malignant Jaundice Investigations.

A second series of investigations, to which continuous attention was given throughout the year, is being undertaken to determine the means by which the infection of the canine disease, malignant jaundice, is transmitted from animal to animal. The experiments necessary are proving arduous and protracted, but patience and close personal application to every detail have already been rewarded by discoveries that are almost startling in their strangeness.

Malignant jaundice is commonly known in South Africa as distemper or hondziekte. It has been known upwards of half a century in the country and appears to now occur from the Cape to the Zambesi. As the most serious and one of the most common diseases affecting dogs in the sub-continent, it is worthy of investigation from its own importance, but the real inducement in studying its means of dissemination is the hope of acquiring knowledge that will be of value in the study of diseases that are of greater moment to man. It is one of a large number of diseases of man and lower animals that are due to the presence and

multiplication of protozoan parasites in the body, and these diseases, and others of more obscure nature, as for instance heartwater and horsesickness, perhaps depend wholly upon blood-sucking parasites for their communication from animal to animal. The channel of infection is known in a few cases only, and in others, as horsesickness, still remains a matter wholly of conjecture. Each new fact discovered in relation to the transmission of any disease through intermediary hosts is therefore of considerable scientific and economic interest, and I accordingly attach much importance to the disclosures made by the malignant jaundice experiments.

The experiments conducted up to the middle of November are recounted in an article contributed under the title "Transmission of Malignant Jaundice by a Species of Tick" to the *Agricultural Journal* of Cape Colony, for November 21st, 1901, and read at about the same time before a meeting of the South African Philosophical Society. The investigation is still incomplete, and it has been decided to postpone the publication of any further detailed report until the close of the present year; hence all that it is desired to record here is a bare statement of the results that have been attained to date.

It has been demonstrated beyond all question that malignant jaundice is transmitted by the common tick infesting dogs at the Cape, *Hæmaphysalis leachi*, Andouin (determination by Professor G. Neumann, Toulouse, France). For a proper understanding of the experimental findings it is necessary to explain the life cycle of this parasite. There are four life stages, namely: the egg, the larva, the nymph, and the adult. Only as adults may the sexes be distinguished so far as known. The female becomes greatly distended with imbibed blood and drops from the host. In some sheltered place she lays her complement of eggs, laboriously extruding them one by one to a number of about three thousand. These eggs hatch a month or more after the female drops, each producing an active though very small creature, the larva. Sooner or later the larva destined to mature finds a host, and for about three days remains attached to the skin, gradually becoming distended to its limit. It is still smaller than a pin's head when it falls off and seeks a place of conceal-

PLATE 1.

Dog Tick.

(*Hæmaphysalis leachi*, Audouin).

1. Larva, eight times natural size; 1*a*, natural size.

2. Nymph, eight times natural size; 2*a*, natural size.

3. Male adult, eight times natural size; 3*a*, natural size.

4. Female adult, eight times natural size; 4*a*, natural size.

The hair lines about 1, 2 and 4 show the size to which the respective stages of the tick swell by the absorption of blood. Compare 1 without the hair line to 4 with hair line to realise the immense relative size of the engorged female.

5. Fully engorged female adult, natural size.

6. Female depositing her eggs, twice natural size.

7. Engorged female from the front, to show depressions of shield *a*, genital orifice through which the eggs appear.

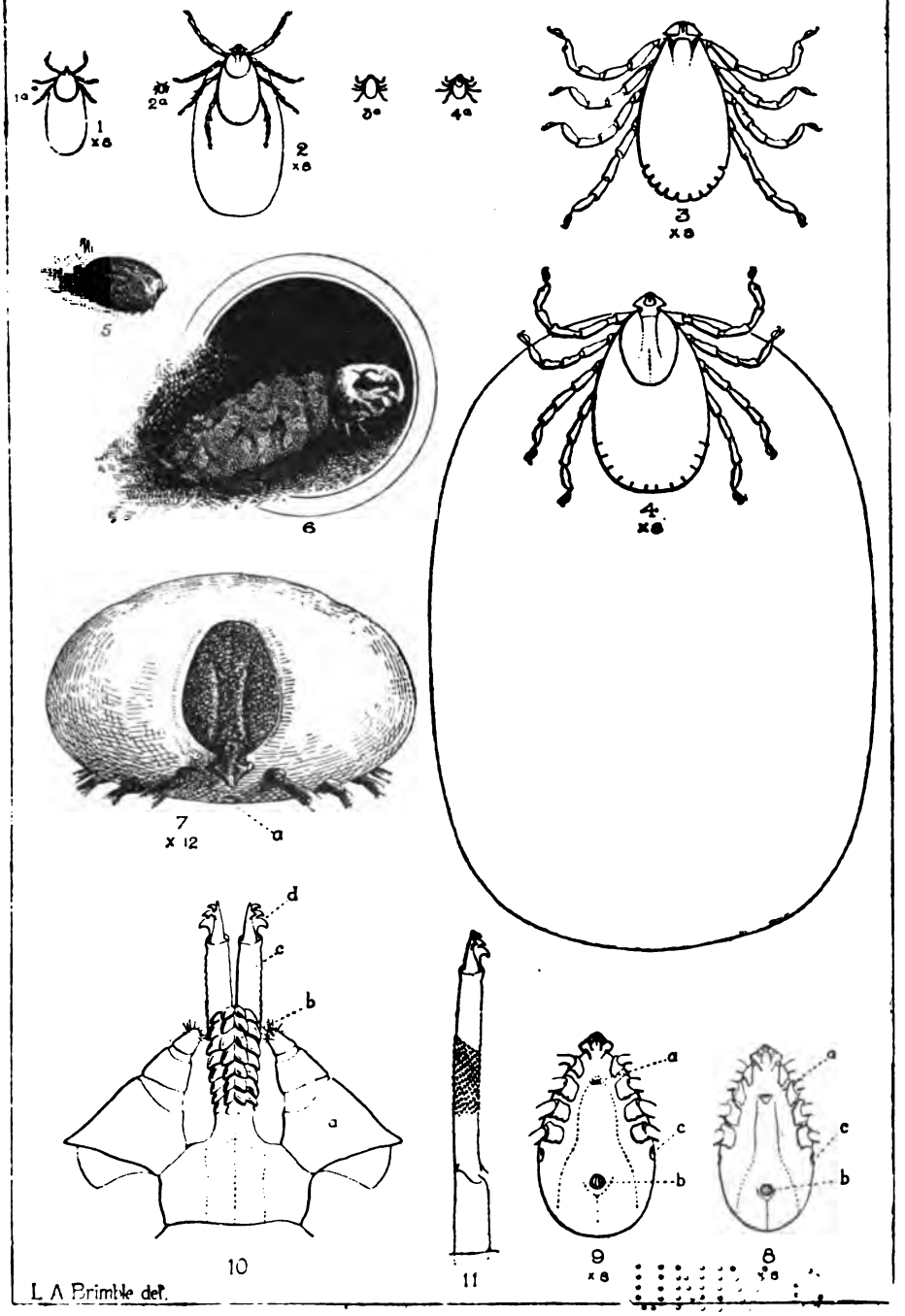
8. Male adult from beneath, eight times natural size; *a*, genital orifice; *b*, anus; *c*, spiracle or breathing orifice.

9. Female adult from beneath, eight times natural size; details the same as in 8.

10. Mouth-parts of larva from below, much magnified; *a*, palpus *b*, hypostome or sucking organ; *c*, mandible extended to full length *d*, mandibular hooks.

11. One of mandibles from larva.

PLATE I.


1a
1
x6
2a
2
x6
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7
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c
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10
11
a
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x6
L. A. Brimble del.

ment. Ten or twelve days later in summer weather the larval skin ruptures, and the active host-seeking nymph appears. A host found, the nymph engorges in about three days and then drops off and hides away to moult, as did the larva. The second resting spell is longer than the first, but within a month in the warm season the adult has come forth and is searching for its prey. The sexes attach independently. Spermatazoids are soon developed by the male and it then lets go its hold at irregular intervals and roams about the host in search of a mate or mates. If mating takes place without loss of time, the female becomes engorged and ready to fall about the tenth day; it is then the bloated, rounded, blue-black creature, about seven-sixteenths of an inch in length and one-quarter of an inch in width, that is commonly recognized as the tick. With the fall of the female the cycle as here outlined is complete. It should be noted that each individual tick requires three feedings to arrive at full maturity and that three different animals may, and probably do in the ordinary course of events, serve as hosts.

Cases of fatal malignant jaundice, affirmed by blood examinations, and by the *post-mortem* appearances of the viscera, have been produced in the experiments by three successive generations of the tick; the first in April, 1901, the second in September, and the third in February, 1902. The tick has been found normally innocuous in all stages, and always innocuous in the larval and nymphal stages; the three successive generations proved pathogenic only as adults, being harmless as larvæ and nymphs to the various susceptible dogs on which they were reared. Moreover, what is equally remarkable, the larval and nymphal stages seem incapable of deriving infection in their feeding that they can pass on to the adult stage. The capacity to infect is lost with the generation unless renewed by the adults, which is to say,—the progeny of adults that induced the disease but which became engorged and left the animal before the fever set in, are non-pathogenic, whilst the progeny of adults, be these infective or not themselves, that became engorged after the animal had really sickened, are pathogenic. The males are suspected of being innocuous, they not having given rise to fever in two instances when applied alone; and in two other instances males

PLATE .

NEWLY INTRODUCED CRYPTOLÆMUS LADYBIRD.

(*Cryptolæmus montrouzieri*).

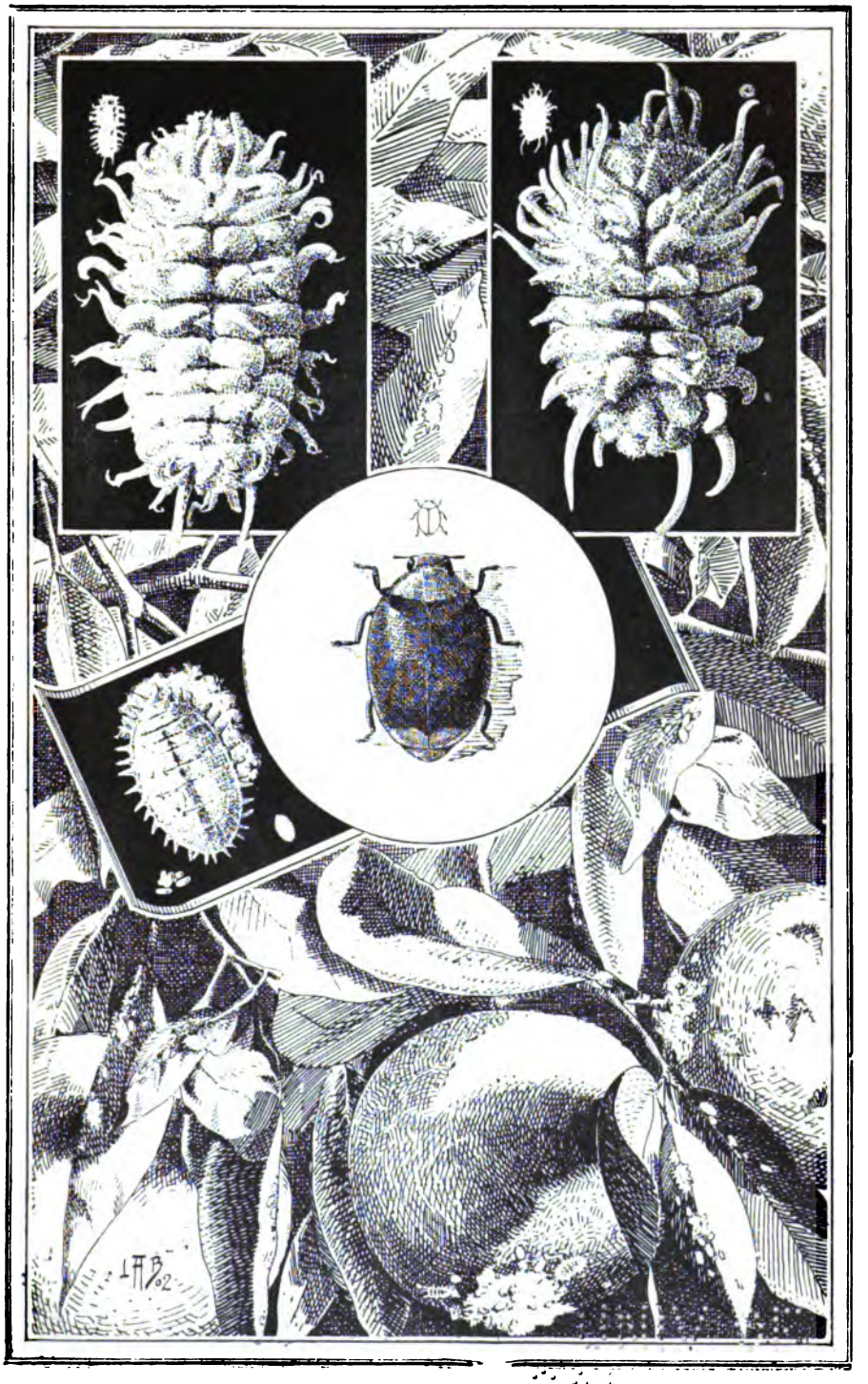
ADULT FEMALE BEETLE in centre.

FULL GROWN LARVA in upper left hand corner.

PUPA in upper right hand corner.

ADULT MEALY BUG to left of beetle with its egg mass and a few eggs enlarged for comparison with the *Cryptolæmus* larva which it superficially resembles. The principal figures are all six times natural size. The small figures show the actual size.

BACKGROUND orange foliage and fruit infested with mealy bug being preyed on by Cryptolæmus, half natural size.



been liberated in seemingly suitable localities. Several hundred were taken to Martindale in the Bathurst division during April and liberated in mealy bug-infested pineries, and numerous others were placed on rows of pine apple plants enclosed under wire netting. Up to the present the owner of the pineries, Mr. H. Dugmore, has been unable to find any descendants of the insects, but we still have hopes that the species has managed to establish itself. A supplementary sending was recently despatched to Mr. Dugmore and from it he will try to rear colonies in confinement as we do in the office. Liberations in the Cape Peninsula have been made in Constantia vineyards, on scale infested Araucaria trees at Claremont, in the Municipal Gardens at Cape Town, and on Stephanotis trellises at Green Point. At Wellington large numbers have been placed on mealy bug-infested guava and orange trees on a Blaauw Vallei farm, and the original colony has been reinforced from time to time. Two trees were here placed under netting, one under wire screen and the other under a bed canopy, but on these trees as on the unenclosed ones few of the insects were to be found after three months. However we have some reason to expect that the species survives on the farm and will succeed in becoming permanently established. Two sendings have been made to the Natal Government Entomologist and one to the Curator of the King William's Town Botanic Gardens.

The Cryptolæmus ladybird multiplies rapidly under the conditions favourable to it. In our breeding jars, it passes through its entire life cycle in six weeks of summer weather. As cold weather sets in its activity decreases, but it keeps on feeding if supplied with food and even in mid-winter passes through a generation in twelve weeks. It feeds on the various species of mealy bugs and on allied scale insects both in its larval and adult stages. At the office the *Dactylopius* commonly found on oleander and *Eriococcus araucariæ* of the Norfolk Island Pine and other species of Araucaria have been the principal insects supplied as food.

The object of establishing the Crytolæmus ladybird at the Cape is to have a more efficient natural check on the multiplication of mealy bugs than we have in our indigenous predaceous and parasitic insects that prey on

these pests. We have a species of mealy bug in Constantia vineyards, and one in the pineries of East London and Bathurst divisions, that have aroused some apprehension on the part of the growers concerned. We have found that the vine species at least has an inveterate and very persistent enemy in one of our native ladybirds, a very small undetermined species, but unfortunately this ladybird in turn is preyed upon industriously by a very pretty wasp parasite (*Homalotylus* sp. according to Dr. L. O. Howard), that prevents it from keeping its prey suppressed satisfactorily. To what degree the Cryptolæmus will fulfil the object we have in view remains to be determined by experience. Thus far we are not certain that it has become established out of doors, and until we are, it is our intention to maintain a colony in confinement, a troublesome and difficult proceeding in Cape Town, where insects that can serve as food are uncommon.

Red Scale Fungus.—As promised in last year's report, further attempts have been made to make use of the fungus disease, that attacks the Red Scale (*Aspidiotus aurantii*) in various parts of the world, for the destruction of this notorious scale pest at the Cape. This fungus, we believe, is identical with one found by Professor P. H. Rolfs in Florida, and referred to by him as *Sphærostilbe coccophila*. Professor Rolfs made artificial cultures and succeeded in infecting and destroying previously healthy *Aspidiotus perniciosus* by the distribution of these cultures over trees infested by the scale. The Natal Entomologist reports that owing to this fungus the Red Scale is only a minor pest near the coast in his colony; and in Bathurst Division and eastward in the Cape Colony, we have found that one of our native scales is much subject to the disease. Even about Cape Town the fungus occurs naturally but so rarely that we seldom come across it.

Artificial cultures were made at the office by Mr. Mally. Gelatine, bread, acidulated bread, and sugar-agar were used as media; the sugar-agar, suggested by Mr. W. Robertson of the Veterinary Department, was found to answer best. The acidulated bread grew an abundance of the fungus but common moulds were troublesome with its use. All the cultures were started from fungus collected on a native scale at Port Alfred, Bathurst. When an abundance of

fungus was on hand, quantities were taken to scale infested trees and attempts made to establish the disease on these by means which will be described presently. The trees selected were part of the camphor plantation at Tokai in the Cape Peninsula. The camphor is very subject to the Red Scale and this plantation has boen severely infested for several years. Three series of tests were made and a score or more trees included in each: (1) Twigs bearing numerous fungus-destroyed specimens of the native scale were tied in contact with Red Scale; (2) Sugar-agar cultures of the fungus were broken up in water, and strips of sacking wetted in the mixture were wrapped like puttie bands round and round large branches; (3) water containing sugar-agar cultures finely sub-divided was applied in a mist spray from a knapsack pump. Trees heavily pruned, some moderately pruned, and some not pruned at all were treated in each series. The work was done during warm winter weather late in August. To vary the experiment, it was arranged through the kindness of Mr. A. E. Gower, the Superintendent of the plantations, that about half the trees be sprayed lightly each morning with clear water; these sprayings were continued up to October 14th. No development of the fungus has been found on any of the trees, and we are forced to conclude that there is no future for the disease as a scale destroyer in this section of South Africa. Humidity and heat together seems essential for its rapid multiplication, and this climatic condition seldom occurs for long in the Cape Colony.

EXOCHOMUS PILATEI LADYBIRD FROM CALIFORNIA.—The Red Scale is such a pest at the Cape that we lose no opportunity to attempt the introduction and colonization of its exotic natural enemies, and in return for favours we are rendering his State, Mr. Edw. M. Ehrhorn, the Entomologist of Santa Clara County, California, is doing what he can to assist us. On March 3rd he despatched, *via* New York and London, 102 adults of *Exochomus pilatei*. This is a large ladybird that feeds on the Red and other armoured scales and on the young of soft scales. The specimens were sent in four wooden pill boxes, 25 or 26 to a box, with a little moss to give them foothold, and crushed dates fastened in place under

gauze to afford them sustenance. The pill boxes were packed in a larger box with crumpled newspaper as filling. The sending travelled in the ship's cool chamber from England to the Cape, a journey of seventeen days. From some unexplained delay *en route*, it took 53 days for the specimens to reach Cape Town; however, 66 were still alive and active. These survivors were put in large glass jars and supplied with Red Scale as food; but because they fed little and were diminishing slowly in numbers they were removed, June 17th, and placed within a 8′ x 4′ x 3′ specially made wire cage placed over some plants in the Municipal Gardens that were heavily infested with Red Scale. The plants grew in a shady, secluded nook, and we had hopes that under the improved conditions some of the beetles would manage to survive until spring and then propagate. Live scale was still abundant when the cage was removed, December 17th, but a careful search did not disclose a single one of the insects in any stage. None of the beetles are thought to have survived much later than August 28th, on which date five were seen through the gauze.

Mr. Ehrhorn sent some more specimens by mail on September 12th. They were packed like the previous lot, but as they left California they were full-grown larvæ or pupæ, not beetles. About 75 were sent, but only 25 reached Cape Town alive, and these all as beetles. The journey occupied 32 days. No attempt was made to keep this lot in confinement, it being turned loose at once on scale-infested plants in the Municipal Gardens.

CHILOCORUS BIVULNERUS LADYBIRDS FROM CALIFORNIA.—The ladybird known as *Chilocorus bivulnerus* occurs from the Atlantic to the Pacific in the United States, and is esteemed as the most important of the scale attacking species. Under date of June 3rd, Mr. Ehrhorn wrote that he had just shipped about 350 pupæ of this kind. The packing was in all respects like that of the March sending of *Exochomus*, and from England to the Cape the box lay in the cool room of the vessel. To our disappointment not one of the insects reached the Cape alive; all had transformed to the beetle stage and perished without leaving an egg to reward us. Not unlikely the journey across the United States, coming as it did in the heat of summer, had a disastrous effect.

MEGILLA MACULATA LADYBIRDS FROM MASSACHUSETTS.—Very early in the year an order was placed with a commercial entomologist in Massachusetts to collect and ship us ladybirds of beneficial species. By getting hibernated specimens and having them come in cold storage, I hoped to get the insects here alive and in condition to propagate at once. Consequently the instructions were to procure the creatures as soon as they appeared in the spring and to send along consignments each week. The pea fields from Maryland and Deleware northwards were mentioned as likely places to get the species in abundance. The party engaged, unfortunately, failed to bestir himself at the proper time, and later satisfied his conscience by sub-letting the work to a friend who though anxious to please had not sufficient knowledge of the subject to make a successful collector. He failed to find good collecting ground in localities he was advised to try by professional entomologists, and finally was led to advertise in rural papers that he was prepared to buy ladybirds at a fixed price per hundred. The unusual advertisement attracted reporters and he foolishly allowed himself to be interviewed by sensation mongers. The result was that newspapers all over the United States and many in Canada and England soon contained paragraphs on the subject in which a little truth was obscured in a mass of absurd and sensational statements. After all that was said less than a thousand beetles were collected and despatched, and these were not hibernants as were wanted but late season specimens. They were all of one species, *Megilla maculata*, an aphis feeder of good repute. In accordance with instructions they were packed in a wooden box of about one-fourth of a cubic foot capacity, with cleats tacked against the sides and crumpled paper to serve as foothold, and with a few crushed raisins, dates and figs to serve as food. They arrived in Cape Town on August 26th, 35 days from the time they were despatched. Two-thirds of the specimens survived the journey and were liberated on aphis-infested plants at Rondebosch. As was to be expected of aphis feeders obtained in mid-summer they manifested no disposition to procreate when set free and it is feared that none survived long enough to be so minded; at all events we have seen no descendants.

HIPPODAMIA CONVERGENS LADYBIRDS FROM CALIFORNIA.—The Woolly Aphis of the apple tree ranks high as a fruit tree pest in Cape Colony and one of the ambitions of the office has long been to establish insects that are active in preying on it in other countries with the hope that its injuries may thereby be materially lessened. It is a pleasure to record that one of the species we most want has at last been introduced in large numbers and gives promise of locating itself here permanently. This species is *Hippodamia convergens.* It is a common and widespread insect in the United States, and whilst it feeds on a great variety of aphides and to some extent on soft scale insects, and even small caterpillars and grubs, it appears particularly partial to the Woolly Aphis and its close allies. When on a visit to California two years ago, I learned from Mr. Ehrhorn that it was very abundant in the mountains in his section of the country and that he sometimes saw immense numbers hibernating there in winter. He told me that it lived chiefly on the Alder louse, an aphis congeneric with Woolly Aphis, and he readily agreed to gather and send me hibernants when winter came on. The winter 1900-1901 passed without his finding numbers, but this year he was fortunate in locating myriads. Under date of November 7th he wrote as follows:—

"I take pleasure in sending you a good shipment of ladybirds through your New York agent; it consists of 15,000 more or less *Hippodamia convergens* beetles which I was able to collect in a hibernating state . . . . If this shipment arrives in good condition and you would like another, cable me "morebug" and I shall endeavour to meet your wishes. Where I gathered the present specimens, there were billions; the ground was red with them and was covered in patches of ten feet square to a depth of fully two inches."

The sending arrived in excellent condition. The box was about fifteen inches each way. Dates were fastened against the top, and the beetles were loose amongst straw and leaves. No holes for ventilation had been made. The chill of the cool room on the ship had kept the creatures dormant, and only a small fraction, perhaps under one per cent., had perished on the way. No attempt was made

to count the specimens, but it is certain that Mr. Ehrhorn's estimate was low and that 50,000 would have been nearer the mark. The box arrived on December 17th, having been forty days on the way. The message "morebug" was at once despatched, and in response two other boxes, each containing quite as many as the first, were received on February 13th. They came through in about the same time. The ladybirds were extremely active, and swarmed out like bees from a disturbed hive as soon as the boxes were pried open.

Both lots were liberated as soon as possible after their receipt. The first was distributed principally between five estates in the Cape district and the second principally between the same five estates and a number of fruit farms in the Stellenbosch and Paarl divisions. Woolly Aphis, probably, has never been more abundant than this year in this part of the Colony, and was extremely plentiful on all the estates where the ladybirds were given their liberty. It is still too early to say whether or not the species will remain in cultivated orchards and to what extent it will do the work desired of it, but in view of the immense numbers introduced and the readiness with which it took to the Woolly and other aphides, there is little doubt felt as to its establishing itself. The first lot began to oviposit within a few days of being freed and adults of the first Cape generation were found five weeks later. The second lot was copulating freely when liberated and doubtless soon laid eggs.

These shipments of ladybirds are unique as the largest ever made, and probably no shipment before ever arrived at its destination in such perfect condition. It is worthy of mention that the distance traversed is over 12,500 miles or half the circumference of the earth.

Chinese Red Scale Parasite.—The greatest boon that could be conferred upon the citrous fruit industry of Cape Colony would be an efficient natural check for the Red Scale. The establishment of such a blessing in the country would be worth many thousands of pounds sterling. Treatment of infested trees with hydrocyanic acid gas can be depended on to keep the scale in check, but only at an enormous cost, so much so that fruit-growers

PLATE 3.

NEWLY INTRODUCED HIPPODAMIA LADYBIRD.

(*Hippodamia convergens*).

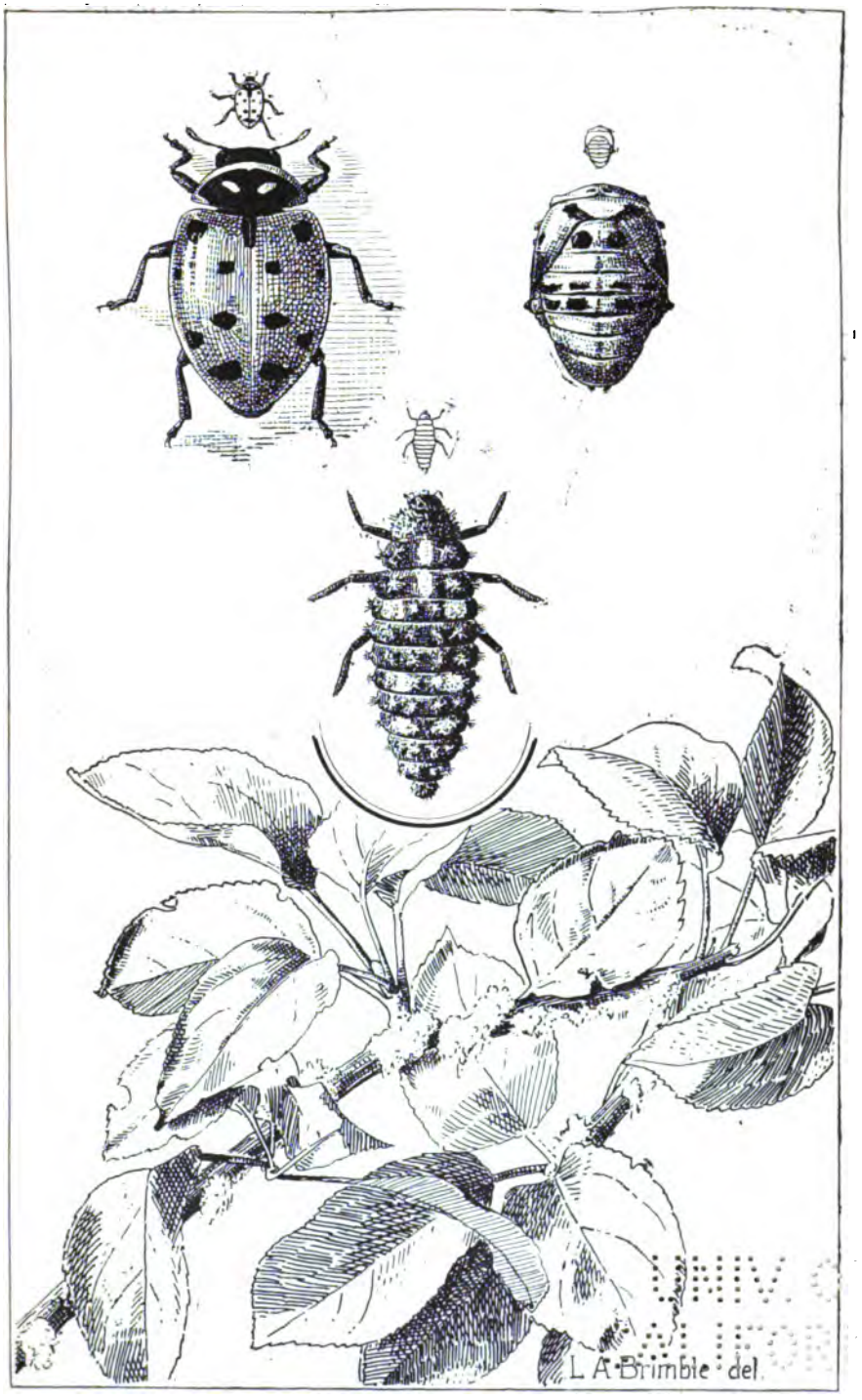
ADULT FEMALE BEETLE in upper left hand corner.

FULL GROWN LARVA in centre.

PUPA in upper right hand corner. The three figures enlarged six times and actual size shown by line sketches.

WOOLLY APHIS on apple twigs beneath. The beetles and larvæ attack this pest ravenously.

PLATE III.



would be much discouraged if they had to consider it a permanent measure. Fortunately for the Colony, this country is only one of many in which the Red Scale is a costly pest, the advantage of this fact being that many governments are interested in locating natural enemies, and that we are certain to profit by the discoveries of each and all. California gave us the hydrocyanic acid gas remedy, by far the best of all the artificial checks, and there is now some hope, I am pleased to report, that the same State may lay us under a heavier debt of gratitude by furnishing us with an efficient natural check. The California State Board of Horticulture has spent large sums during the past twelve years in defraying the expenses of systematic searches for natural enemies of Californian insect pests by special entomological agents. In the fall of 1900, one of its agents, Mr. George Compere, was fortunate in discovering in China a parasite of the Red Scale, and it is on this creature that our hope is now based. The following abstract of a letter, dated November 20th, 1901, from Mr. Alexander Craw, the Entomologist of the Board, will serve to show the success of Mr. Compere's sending to California and our reason for expecting to soon participate in any beneficial results that may lead from it. The letter reads :—

> "I have good news for you. On page 26 of your report for 1900 you refer to our search for the parasite of the Red Scale. Well George Compere visited China on his last mission where he found evidence of internal parasites in the Red Scale. After some searching he discovered a small orange tree about four feet high and saw a female parasite depositing her eggs in the scales. He purchased the tree from the owner and sent it to me. Most of the leaves dropped on the voyage, but at the base of the trees the scales were very thick as they were there protected by a heavy growth of weeds. I placed the tree in a glass case and it has developed nicely. Since then the scales have hatched and infested the twigs and leaves and the parasites are increasing rapidly, Of course the scales are increasing because I am removing the *Chalcids* as fast as they develop. The first to emerge were six on May 31st. None appeared during June. In July I found 36, in August 81, September 143, October 331, and up to date this month I have taken out 590. All have been sent out, and with one exception the sendings have reached their destinations in good shape on the following day. If we succeed in establishing the species I shall colonize a small tree and forward it to you next season.... It is smaller than *Aspidiotophagus citrinus* and prefers the one-third to two-thirds grown scales."

In this connection it is worth recording that we have a parasite in the country for the Red Scale though it is sadly inefficient at holding the pest in check. It appears to be the *Aspidotophagus citrinus* alluded to by Mr. Craw,

and which in California is considered as the most valuable parasite for *Aspidiotus citrinus*, a very close ally to the Red Scale. This parasite was noticed in Bathurst five years ago and again during the past year, but whilst upwards of half of the scales on some twigs are affected, no appreciable advantage seems to be derived from its presence; the trees suffer very severely from the scale. About Cape Town, the parasite has been found with a pineapple scale (*Aulacaspis bromeliæ*) and a fern scale (*Chionaspis braziliensis*) in conservatories, and with the Red Scale on camphor trees at Tokai.

Distribution of Beneficial Insects.—It is still uncertain whether or not our efforts (see 1900 Report, page 5) to get the South African parasites of the Black Scale (*Lecanium oleæ*) established in California have been successful. Colonies in jars are being reared by Mr. Edw. M. Ehrhorn, the Entomologist of Santa Clara County, and by Mr. Alexander Craw, the Entomologist of the State Board of Horticulture, and liberations of the principal species, *Scutellista cyanea*, have been made in orchards infested with the scales. Until at least the species mentioned has began to multiply in the orchards, it is our hope and intention to continue sending supplies of the parasites whenever opportunity permits, and we are endeavouring to breed both the scales and the parasites in confinement that we may not have to depend upon the small scattered lots that occur naturally. In California the scale is the very worst of scale pests, infesting citrous and stone-fruit trees, the olive, and numerous ornamentals to a highly injurious extent over an immense area, whereas at the Cape it is practically confined to the oleander and *Myoporum insulare*, and cannot be called common on these plants. It is believed that the scarcity here is due to its parasites, and we feel sanguine that the establishment of the parasites in California will be followed by the subjection of the pest there, and the conquest of this insect by natural enemies will be an event in economic entomology second in importance only to the triumph of *Novius* (*Vedalia*) *cardinalis* over *Icerya purchasi*, the Australian Bug or Dorthesia.

Twice during 1901 we were fortunate in locating sufficient parasite-infested Black Scale to form sendings to

California, and both lots were despatched to Mr. Alexander Craw. The first was sent from Cape Town on February 27th. It was a single small box, containing infested cuttings from the plants wrapped separately in tissue paper and layered with cotton wool, and was despatched from Cape Town to Southampton in the cool chamber of the carrying vessel; from London to San Francisco it travelled by express. An exasperating delay occurred at the New York Customs House, and it was not until April 23rd that it finally reached its distant destination. Mr. Craw reported that the myoporum cuttings were shrivelled and the scales dead, but that the pieces of oleander were in fairly good condition and still bore living Black Scale despite the eight weeks of confinement in a tight box; later it was learned that a few parasites were reared from the material. The second sending was despatched to Mr. Craw by letter post on October 2nd. It consisted of infested oleander cuttings separately wrapped in tissue paper and interlaid with cotton wool as before, and was sent in two light wooden boxes, each of which when packed weighed about four pounds. The journey was a remarkably quick one, the boxes being delivered on October 31st. The contents were in excellent condition, several live parasites and many crawling larvæ of the scale being found in the papers, and parasites continuing to emerge from the material for some days afterward.

The Government Entomologist of Ceylon is very desirous of establishing the cochineal insect in his country, and from assistance rendered by this office he has presumably succeeded in getting a mother colony located on the island. During 1899 several sendings of our wild cochineal, so common on the thin-leaf prickly pear that thrives in waste lands about our towns, were made to him and from these he managed to firmly infest a plant of *Opuntia coccinellifera* in his garden. This species (or variety) he considers inferior in value to the typical cochineal insect, and as the latter is easily procurable in the Cape Town Municipal Gardens several sendings of it have been made. For despatch an entire leaf-joint of the plant bearing an abundance of the insect is wired securely in a wooden box and sent by sample post. Infested

fruits have been found to carry badly but leaf-joints remain sound for a month or six weeks. One sending despatched February 26th, arrived at its destination on April 3rd. The joint of Opuntia was fresh and green and the insects, present as full grown females, plump and apparently healthy when the box was opened, but unfortunately the insects died later without having reproduced. Another sending, despatched on September 5th, and delivered on October 19th, arrived in a more satisfactory condition. Mr. Green wrote :—"The plant came in excellent condition, so much so that I am going to plant it and expect it to strike root. A large number of the mature insects had become detached, but there was a nice lot of young larvæ wandering about on the paper packing inside of the box and other larvæ had attached themselves to the joint."

The distribution of Vedalia to suppress outbreaks of Australian Bug (*Icerya purchasi*) is still one of the routine duties of the office, and during 1901 about twenty-five colonies of twenty-five to one hundred specimens were sent to various parts of the Colony, but chiefly to districts along the northern border. One large colony, procured at the cost of nearly a week's searching, was sent by request of the Governor to Mauritius, but owing to long delays on the passage it arrived in a worthless condition.

Hydrocyanic Acid Gas Fumigation.

Orchard Fumigation.—Owing to the greatly disturbed condition of the country due to the presence of the enemy in many districts, and to martial law restrictions, which militated against the night operations of fumigating and the movement of apparatus from place to place, no special efforts to urge the fumigation of orangeries for the destruction of scale insects were made during 1901. Notwithstanding the troublous times, however, the treatment of the trees by this method has been practised by many as the sales of cyanide for fumigation uses by the Department of Agriculture make evident; a number of applications for

supplies of the article were unfavourably considered for military reasons, yet the sales for the year total to above 3,500 pounds, and were sixty-eight in number. The price charged has been 1s. 2d. a pound in case lots (224 lbs.) and 1s. 3d. a pound in smaller quantities. Only the 98 to 99 per cent. pure cyanide is sold.

Railway Coach Fumigation.—The use of the gas for the destruction of vermin in sleeping carriages of the Cape Government Railways has now been practised for three years with perfectly satisfactory results and without any accident. No complaints are now received and no vermin are seen so the measure may be regarded as largely precautionary. The railroad authorities import cyanide for their own use.

Gaol Fumigation.—At the earnest solicitation of the Colonial Secretary's Department, this office undertook the superintendence of fumigation operations for the destruction of vermin in the Tokai and Kimberley gaols. I was not averse to rendering the desired assistance in these cases, since they afforded an opportunity of demonstrating that the treatment of extensive premises may be successful and quite safe under skilled supervision. The operations at Tokai were simple and occupied two days only; but those at Kimberley were beset with difficulties and required over two weeks' attention from the Assistant Entomologist, who acted under my instructions. A large force of workmen were requisitioned to prepare the building for the treatment. The laps of the sheets of corrugated iron forming the roof were choked with bagging, the open spaces under the eaves plugged by filling the gutters with clay, and the air shafts projecting through the roof made tight by blanket coverings. Large openings were made through the wooden ceilings and many of the door frames loosened that the gas might find free ingress back of them. The corridor of the main prison, which is ninety feet long and which extends in cupolas to a height of fifty feet, together with all the cells leading from it, both on the ground floor and in the gallery, was treated as a single space; it took 129 pounds of cyanide divided into forty-three three-pound charges. Altogether 271 pounds of cyanide were used. The success of the operations both at Tokai and Kimberley

was very gratifying to the authorities; but although no vermin at all were found alive in either place after the treatment, both are now, after the lapse of a year, reported to be again badly infested. It is understood that the Colonial Office contemplates having these and other gaol premises treated by the process, to the exclusion of other measures excepting ordinary cleanliness, as often as circumstances render it expedient. The proposal to adopt the remedy has long remained in abeyance, but a start has at last been made, a turnkey given lessons by us a year ago having instructions at the time of writing to refumigate the Tokai gaol. Hydrocyanic acid gas for the destruction of vermin may be very profitably employed not only in gaols but in police and military barracks, in asylums and other buildings under Government control. Certainly no other means that may be used to exterminate vermin approaches this measure in simplicity or effectiveness, or, considering the results attained, in economy. The various Government departments might each be left to attend to the institutions under its jurisdiction, but perhaps a higher degree of success with less risk of accident might be obtained were the Public Works Department to assume entire charge and to assign particular men to the duty.

Full directions for the employment of the gas in indoor fumigation is given in an appendix. [See page 74.] Instructions for its use in orchard fumigation, together with information on the preparation of the necessary tree covers and other apparatus is published in a pamphlet of 27 pages issued in January of the present year (1902). Copies may be obtained on application.

Experiments for the Plague Administration.—Professor W. J. Simpson, the medical expert engaged by the Government to give advice during the epidemic of plague in Cape Town, became interested in our uses of hydrocyanic acid gas; and with the idea of having the measure utilized in the cleansing of premises in which cases of plague had occurred, he arranged that this office experiment to determine the minimum strength of the gas necessary to destroy bedbugs and also that we supervise the fumigation of a few premises to demonstrate to the satisfaction of the authorities concerned the efficacy of the gas in practice for the destruction of

various sorts of house insects. A large number of tests were performed, several demonstrations made, and an officer fully instructed in the conduct of the operations; but owing to the decline of the epidemic and also perhaps to the departure of Professor Simpson, the proposition to make extensive use of the measure was allowed to drop.

The bedbug was found more refractory to the effects of the gas than any of the other common house insects. Gas generated at the strength of one ounce of cyanide to 200 cubic feet of space was found to stupify all bedbugs exposed to it for an hour, but a proportion, equivalent to ten to fifty per cent. in different tests, was found to revive after a few hours. The proportion of survivors diminished as stronger gas and longer exposures were used, yet three out of fifteen of the creatures lived through an hour's exposure to 1oz. to 155 cu. ft. gas; of this three two remained too feeble to subsequently provide for themselves. Two hours' exposure to the same strength killed every bug in these tests. Most of the tests were made in a photographic dark room approximating 235 cu. ft. in capacity at temperatures between 56° and 64°F. Only active, healthy-looking bugs, one third or more grown, were exposed, and at least fifteen were used in each test. They were inclosed in bags of gauze suspended at mid-height on the side of the room opposite where the generating vessel stood. Eggs of the bugs have uniformly failed to hatch in three tests after exposure for one hour to 1 in 155 gas; in two of the tests control eggs all hatched, whilst no control was used in the third case.

Cultures of the plague bacillus were found to be unaffected, when exposed by substituting a piece of gauze tied over the top for the plug of cotton ordinarily used for stopping culture tubes, by one hour in 1 to 80 gas, the severest test employed.

Experiments with Insecticides.

The conduct of several series of experiments with insecticides was entrusted to the Assistant Entomologist, and he has succeeded in adding some interesting and valuable information to our knowledge of the subject. His most important discoveries have been with regard to the

lime-sulphur-salt wash. This insecticide is of Californian origin and is very widely used in that state for the suppression of scale insects on deciduous trees. Fruit growers in Australasia and South Africa have adopted the wash for the same purpose, but no one anywhere has heretofore carefully experimented with it with a view of ascertaining how it acts upon the scale insects and whether or not the present preparation of it can be improved. Prolonged boiling and a very heavy lime content have everywhere been supposed to be essential to its success, but Mr. Mally's results strikingly indicate that long cooking is unnecessary, that only a small fraction of the amount of lime called for by the formula now generally used is needed, and that, moreover, the lime need not be freshly slaked. His sprayings were directed against the White Peach-Scale (*Diaspis pentagona*), and he found that the action of the wash was long continued and almost entirely confined to the young insects; those of the insects that had the protection of scales seemed unaffected even by the strongest preparations. Further experiments will be carried on during the coming season. If the past year's findings are confirmed, fruit growers here and elsewhere will be enabled to effect considerable economies in their insecticide accounts. Cheap colonial lime will substitute the high priced imported article, the wash will be prepared at much less expense and far more quickly, and will be applied with less discomfort and less wear on the pumps; as a consequence its use will be largely increased and losses through scale correspondingly reduced.

Disinfection of Vine Cuttings.—Many hundreds of thousands of American vine cuttings are despatched annually from the Government Wine Farm at Constantia, and since phylloxera appeared in the vicinity it has been considered advisable to treat at least those cuttings that are to be sent to non-phylloxerized farms in some such way as would destroy any stage of the insect that might be present. The cuttings are made up into bundles of one hundred each as they are cut, and the plan adopted for treating them last year was to soak these bundles in large vats containing water kept heated by means of steam from a portable boiler; the temperature was maintained between 53°C and 55°C, and the bundles

were kept immersed for five minutes. This treatment is known not to injure the vitality of cuttings and is stated on French authority (see *Agricultural Journal*, 1900, vol. XVI, page 799 and *Le Naturaliste* for 1st March, 1900,) to be fatal to the insect and its eggs. Obviously, gaseous disinfection presents some advantages over hot water disinfection, and this office was asked to determine if fumigation with carbon bisulphide vapour or hydrocyanic acid gas might be substituted without detriment to the cuttings. The killing effect of bisulphide vapour upon phylloxera and its eggs is known, and it may safely be assumed that hydrocyanic acid gas is equally deadly if used say at the rate of an ounce of potassium cyanide to one hundred and twenty-five feet of enclosed space. Professor E. W. Hilgard of the University of California States in the *Pacific Rural Press* for December 22nd, 1900, page 389, that in 1881 he definitely ascertained that in a saturated atmosphere of bisulphide vapour—that is, in a closed space containing an excess of the liquid substance —the vitality of the phylloxera egg is irreparably damaged within less than half an hour, whereas Zinfandel cuttings were not perceptibly affected when exposed for one, two, four, six or twelve hours. Before planting the treated cuttings he trimmed off the ends about half an inch, this being the extent to which the vapour penetrated. Owing to the fact that the vapour penetrated every crevice of the cuttings, Professor Hilgard strongly recommended the bisulphide treatment in preference to immersion in a liquid, he maintaining that the woolly covering of some buds might not get wetted and thus some eggs be indefinitely protected. An exposure of forty-five minutes and preferably more to a saturated atmosphere in a close box, he said, should be given, and then one half inch of the ends of the cuttings cut off to prevent further penetration.

Two tests with carbon bisulphide were made at the office. The exposures were both in a zinc-lined case, the joints about the cover of which were made tight by the pasting on of heavy paper as soon as it was closed. The cuttings were thrown loose in the bottom and an excess of bisulphide placed in saucers supported near the top. In one test the box was kept closed one hour, during which

period an ounce of bisulphide evaporated, and in the other test, for seventeen hours, during which six ounces passed into vapour. About thirty cuttings were exposed in each test, and after the treatment half were clipped at the end and the other half left unclipped.

Four tests were made with hydrocyanic acid gas, batches of about thirty cuttings being exposed in a space of about 240 cubic feet in capacity for an hour with gas present at the strength of an ounce to 160, 120 and 80 cubic feet respectively; and another batch of over one hundred cuttings being exposed at a later date for an hour to the 120 strength.

All the lots treated with one control lot were planted in nursery rows at the Wine Farm by the field manager, Mr. H. J. Wollheim. The results when the vines started into growth in the spring were very definite. Practically every cutting struck root and grew vigorously with the exception of those of the lot exposed for seventeen hours to bisulphide fumes; of this lot not a cutting started, neither of those with trimmed ends nor those without.

It is evident that in so far as safety to the vines is concerned either exposure to bisulphide fumes for an hour or to very strong hydrocyanic acid gas for the same period may be substituted for the hot water treatment. Of the two chemical measures, hydrocyanic acid gas seems the preferable on the score of simplicity, low cost, and absence of any risk of explosion. A strength of one ounce of cyanide to 120 cubic feet is quite strong enough for the purpose; this and the weaker strength used in the tests were found to devitalize eggs of the common oak aphis.

SECTION II.—SPECIAL REPORTS.

TICK-HEARTWATER INVESTIGATIONS.

The disturbance of the country due to the war has confined me to the Cape Town headquarters and given me time, which otherwise would probably have been employed in the interest of horticulturists rather than stock-farmers, to pursue still further the interesting investigation began two years ago into the means by which the destructive disease heartwater is transmitted from animal to animal and disseminated from farm to farm. Throughout the whole year experiments with these objects in view have been continuously conducted, and now at its close I am pleased to be able to report substantial progress. Both from scientific and practical points of view, I believe the investigation is of great importance and feel confident that the findings already made can be turned to profitable account by numerous farmers in the south-eastern districts. Many experiments remain to be conducted before the investigation can be considered finished, and it may be that the pressure of duties more strictly entomological may before many months seriously interfere and perhaps indefinitely postpone the completion of the series of tests that have been planned.

Before taking up the investigations of the past year it is deemed desirable to devote same space to a general consideration of the subject of heartwater, particularly with regard to its historical aspect.

Part I.—Descriptive and Historical.

What Heartwater is.—Heartwater is a specific, often fatal, disease of sheep and goats. Experiments conducted by the Veterinary Department between three and four years ago showed that it can be communicated by inoculation of virulent blood, but that it is non-contagious and that it is acquired on the veld independent of food and drink. It is presumed to be due to a micro-organism which multiplies in the animal's body, but thus far all the attempts made to locate this organism have been unsuccessful. Hundreds of

PLATE 4.

Bont Tick.

(*Amblyomma hebræum* Koch.)

1. Larva, four times natural size ; 1*a*, natural size.

2. Nymph, four times natural size ; 2*a*, natural size.

3. Male adult, four times natural size ; 3*a*, natural size.

4. Female adult, four times natural size ; 4*a*, natural size.

The hair lines about 1, 2, and 4 show the size to which the respective stages of the tick swell by the absorption of blood. Compare 1 without its hair line to 4 with the hair line to gain an idea of the enormous growth of the female ; the increase is about 40 times in length and about 40,000 times in bulk.

5. Fully engorged female adult, natural size ; *s*, spiracle or breathing orifice.

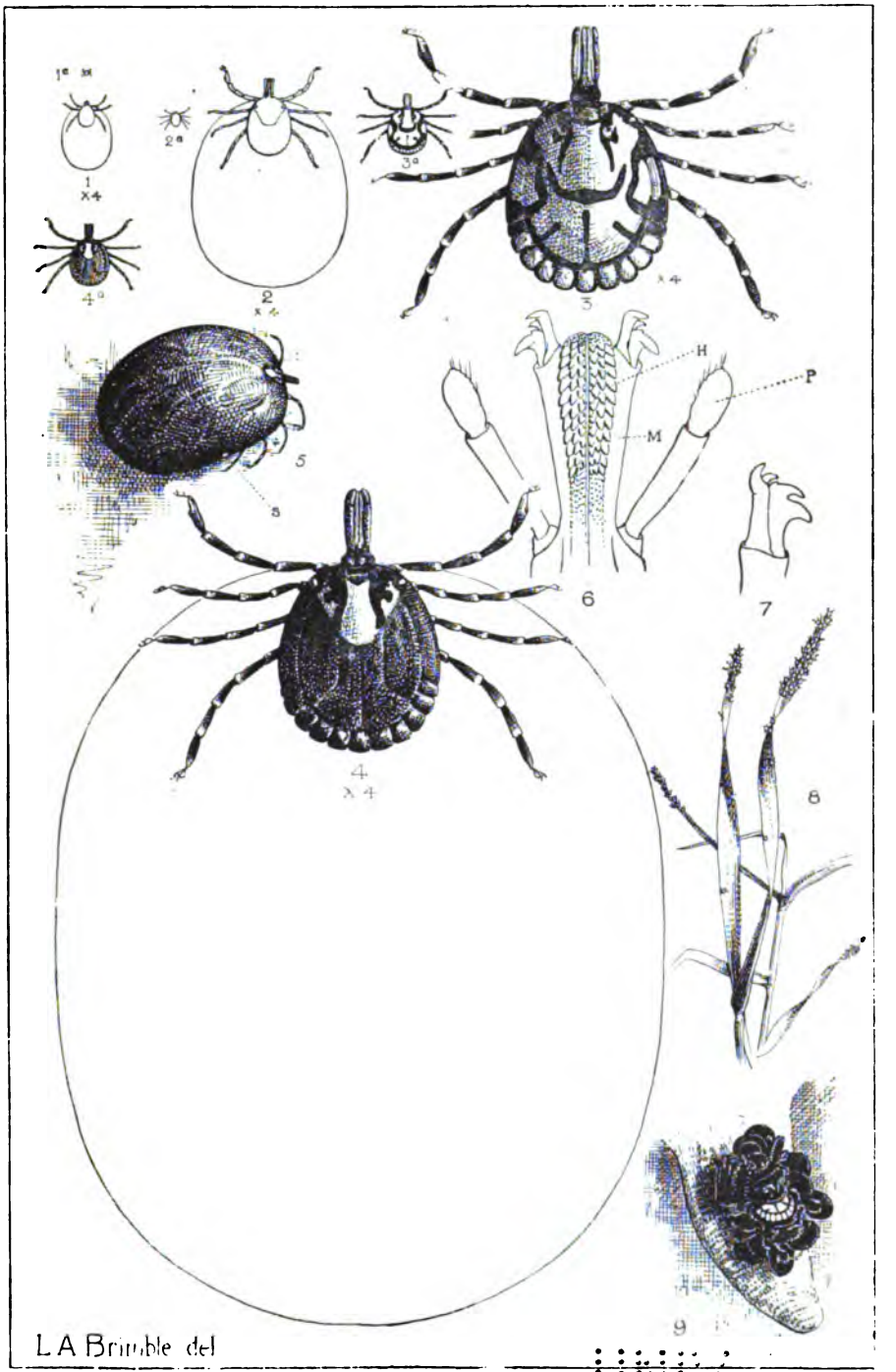
6. Mouth parts of male adult from below, about sixteen times natural size ; *p*, palpus ; *h*, hypostome or sucking organ ; *m*, mandibles with mandibular hooks extended. The hypostome and mandibles penetrate the flesh as far as the base of the palpi. The hooks and a portion of the mandible itself is retractile, and each mandible may be used independent of the other ; the hooks cut the hole into the flesh and with the barbs of the hypostome enable the tick to cling tenaciously.

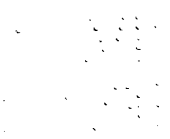
7. Mandibular hooks of female adult.

8. Larvæ, or young ticks, on spears of grass.

9. Male adult with nearly a score of females clustered about him on the teat of a goat. The male is attractive to the other sex after he has fed about five days, and then a number of females may settle about him as in the present instance ; that the functions of the teat may be permanently impaired by such gross infestation is easily imagined.

PLATE IV.





smears from the blood and various organs of the body from at least a dozen cases of the disease were examined in vain by Veterinary Surgeon Robertson during the past year. There is a fairly definite incubative period after infection is acquired and then a period of high fever. The incubative period is about ten days when the infection is from intravenous inoculation, and about fifteen days when it is acquired in the natural manner, by infestation with pathogenic ticks.

The symptoms of heartwater are not specially characteristic. The first indication of the approaching illness in all cases that I have observed has been a sudden rise in temperature. On a few occasions this rise has occurred in the evening and the animals have seemed otherwise perfectly well, yet on the following morning they have been stiff in death. Generally, however, there is a day or two of fever before the animal gives indication other than by its temperature that it is ill. Then it loses appetite and may cease to feed entirely, and its coat becomes rough. The fever period is of variable duration; it may last only three or four days or may last more than ten, and death may cut it short at any time. The temperature generally rises to at least 106° and often to 108°. After the fever, the temperature generally becomes quite normal at once. Sometimes the animal may pass through the fever and recover without having lost a meal or seemed ill at all, but more often there is at least a day or two of complete prostration. Some animals come safely through the fever and die of prostration a few days afterwards. Some die painlessly, others in terrible agony. Convulsive fits are common and may come on at intervals for several days; during them the poor sufferers may wear the hair and skin away by rubbing against the ground and may even destroy their eyes in this manner. Some suffer in silence whilst others bleat and moan most piteously. There is often great difficulty in breathing. The bowels may become costive or loose or may remain acting normally. I have noticed no difference in the appearance of the urine. Altogether, the symptoms are so variable that unless one suspected heartwater, he would be greatly puzzled. It should be remarked that the statements in this and the following paragraphs are based on observations made on goats infected by means of ticks.

The *post-mortem* appearances of the viscera, fortunately, are more characteristic than symptoms in life. Almost always there is a great excess of fluid in the heart-sac, hence the name of the malady—heartwater. This fluid is clear and pale yellow just after death, and part of it coagulates into a jelly-like mass. Sometimes the sac is almost bursting with fluid. The thoracic cavity oftentimes contains several ounces of similar exudation and occasionally some is found in the abdominal cavity. When the heart is cut open and washed the inner lining is generally found to be reddened in spots, as if it had been bruised. Similar lesions are often to be found in the small intestine. The surface of the lungs is usually raised slightly so that the lobules are separated. The abdomen may be greatly distended with food or almost empty. The gall bladder may be full and rounded and, if the animal has been dead a few hours, the surrounding tissues may be stained yellowish, or the bladder may be pale and flaccid.*

HISTORY OF HEARTWATER.—The absence of symptoms by which heartwater can be reliably diagnosed and the non-contagious nature of the malady long served to obscure the fact that it was a specific disease and not the outcome of infestation by internal parasites or of an unsuitable diet occasioned by over-stocking, deterioration of the pasture or the lack of certain food elements in the vegetation. The term "heartwater" came early into use but was made to cover various ills of a dropsical nature that had naught in common with true heartwater, and on the other hand it is not now to be doubted that tens of thousands of sheep have died of the disease whose deaths were ascribed to the still intangible and perhaps non-existent ailment called "gall-sickness." Just when and where heartwater first appeared cannot, perhaps, be ascertained with exactitude, and the following statement made by Dr. D. Hutcheon, the Colonial Veterinary Surgeon, in his 1899 report gives the most definite information on these points that I have been able to obtain. He says:

> "This disease (heartwater) was first observed amongst sheep and goats about 1860, near the coast on the borders of the King William's Town and Peddie Districts, and from that centre it gradually spread north, south,

*For more complete accounts of these phases of the subject see *Agricultural Journal* for 23rd June, 1898, and recent annual reports of Colonial Veterinary Surgeon and Colonial Bacteriologist.

east and west, through the districts of King William's Town, East London, Komgha, Victoria East, Fort Beaufort, Stockenstrom, Peddie, Bathurst, Albany, Alexandria, and portions of Uitenhage, Humansdorp, Bedford, Somerset East and Stutterheim."

It was not until about 1870, however, that heartwater began to attract much attention. The Magistrate of Peddie, in his report for 1864 on the condition of the district, stated in so many words that "sheep thrive throughout the district"; in 1868 he wrote that "sheep thrive well"; but in 1871 he mentioned that "sheep do not thrive near the coast." Without doubt heartwater was the cause. As late as 1870, too, the Magistrate for Albany reported "no serious disease amongst stock," and Albany was then a great sheep district. The East London Magistrate seems to have seldom troubled himself with submitting notes on the condition of stock, and for several years before 1875 there is no report at all from him; in that year however he made amends by submitting the following contribution:

"I have to report that as the country becomes settled, a change gradually takes place in the character of the grasses upon the pasture lands which appear during nearly the whole year clad with richest verdure, but there are so many theories started in explanation of the deterioration which occurs, or rather appears to occur, for whereas in many cases sheep can no longer be kept or young stock reared the larger cattle thrive, and are always in excellent condition that it is difficult to say which is the correct one. This was what took place in the western wards which were first settled by the European grantees, and I may mention that in Ward I (the portion of the district bordering on Peddie), which has only nineteen farms, some 70,000 sheep were depastured by the first occupants, whereas now according to the last census returns not a single head is to be found. The gradual unfitness for sheep is creeping eastwards, for there again upon the Crown Lands which formerly supported numerous flocks, and were the salvation of thousands of sheep from the upper districts in winter months, the mortality among sheep is increasing year by year, and was during the last year very severe indeed."

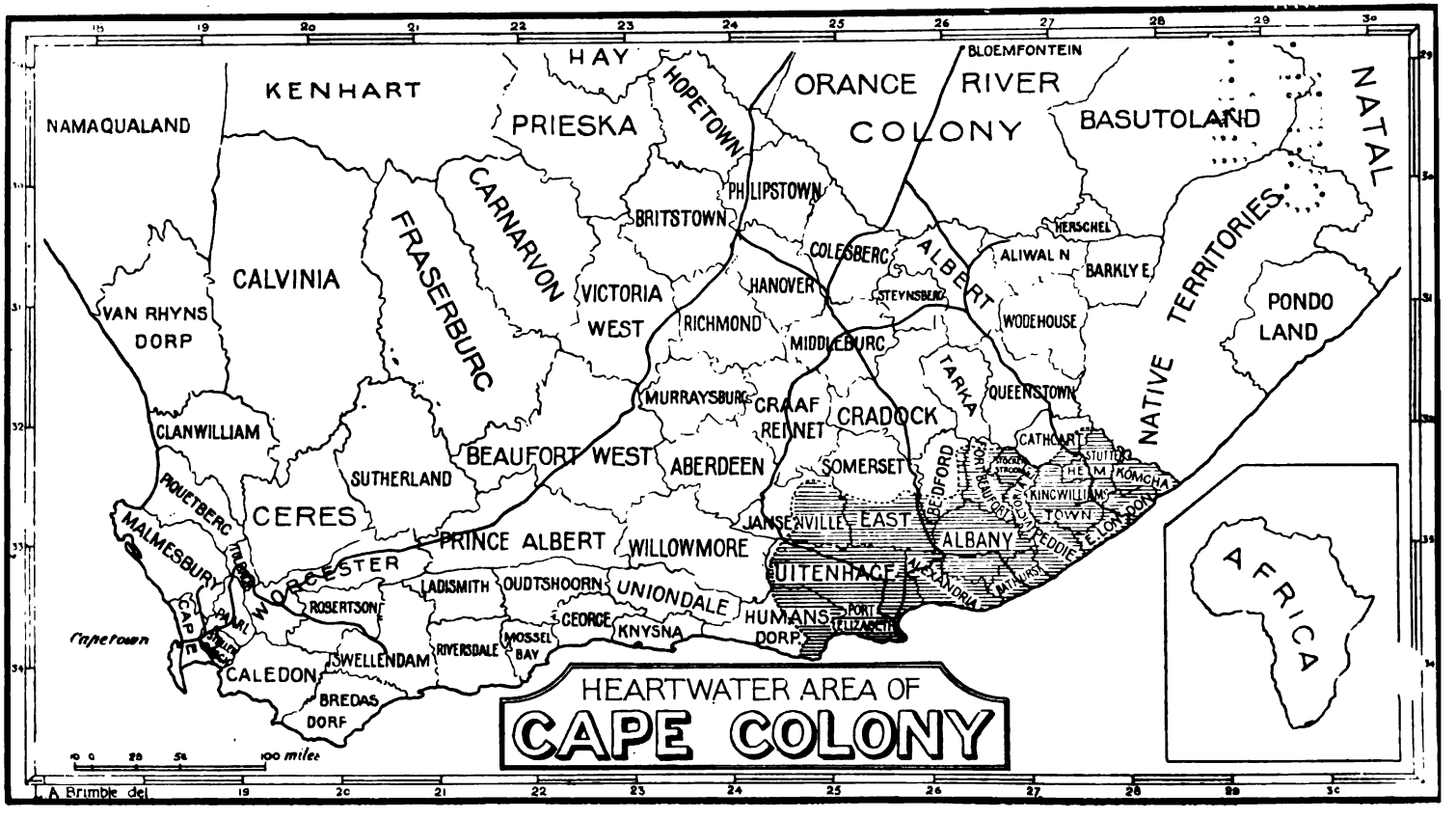
Heartwater is still spreading into new territory but, apparently, not nearly so rapidly as between 1865 and 1875. It at first swept by numerous farms, leaving them for the time healthy for sheep and goats, but gradually it has been closing in on these and its tendency is evidently to invade every one. It is said to spread more quickly in bushy than in open grass veld and it will probably always be less prevalent in perfectly open than in bush country, but I apprehend that it will gradually extend far beyond its present confines and especially fear that it will find the conditions for intense activity almost as favourable in the Zwart Ruggens angora goat districts as near the coast

PLATE 5.

TICK-HEARTWATER RESEARCH.

Map of southern end of African continent, with heartwater area shown by shaded lines. The delineation of the area is from a sketch by Dr. Duncan Hutcheon, the Colonial Veterinary Surgeon.

PLATE V.


HEARTWATER AREA OF
CAPE COLONY
NAMAQUALAND
KENHART
HAY
PRIESKA
HOPETOWN
ORANCE RIVER COLONY
BLOEMFONTEIN
BASUTOLAND
NATAL
NATIVE TERRITORIES
PONDO LAND
CALVINIA
VAN RHYNS DORP
FRASERBURG
CARNARVON
VICTORIA WEST
PHILIPSTOWN
BRITSTOWN
RICHMOND
HANOVER
COLESBERG
ALBERT
HERSCHEL
ALIWAL N
BARKLY E
STEYNSBERG
WODEHOUSE
MIDDLEBURG
TARKA
QUEENSTOWN
MURRAYSBURG
CRAAF REINET
CRADOCK
CATHCART
CLANWILLIAM
BEAUFORT WEST
ABERDEEN
SOMERSET
SUTHERLAND
CERES
PROUETBERG
MALMESBURY
PRINCE ALBERT
WILLOWMORE
JANSENVILLE
EAST
BEDFORD
ALBANY
KINGWILLIAMS TOWN
KOMGHA
STUTTERH
WORCESTER
LADISMITH
OUDTSHOORN
UNIONDALE
UITENHAGE
ALEXANDRIA
ROBERTSON
GEORGE
KNYSNA
HUMANSDORP
PORT ELIZABETH
Capetown
SWELLENDAM
RIVERSDALE
MOSSEL BAY
CALEDON
BREDAS DORP
AFRICA
100 miles
L. A. Brimble del.

where its presence has proved so disastrous. The area now known to be infected is as defined by Dr. Hutcheon in the abstract given above. How far east it extends is an open question. Two years ago I wrote Mr. Claude Fuller, the Natal Entomologist, asking him to enquire if it were known in his Colony. In reply he wrote:

> "Heartwater was noticed by Mr. Pitchford (the Government Veterinarian) three years ago and never since; it is not known locally. The cases being isolated and the origin of the sheep doubtful, it is possible that they may have been introduced with the disease. Anyhow it is only sporadic."

Perhaps the cases observed were of some disease resembling heartwater superficially and not the Cape malady, yet it is possible that the disease occurs all along the coast.

ANIMALS SUBJECT TO HEARTWATER.—Sheep and goats are the only animals known to naturally contract heartwater. Dr. Alex. Edington, the Colonial Bacteriologist, in his 1898 annual report, says he failed to transmit the disease to other animals (kinds not stated) by inoculation, but that by manipulation (not described) he succeeded in infecting a specially prepared ox. In the course of the experimental work of last year, I fed many thousands of pathogenic nymphs from most virulent sources on an old cow without appearing to produce the slightest effect on her health although the ticks retained their pathogenic property and afterwards fatally infected goats; hence it seems unlikely that cattle are easily infected. A number of pathogenic ticks have bitten me without effecting any further discomfort than that occasioned by the bites of non-pathogenic individuals.

I do not know of any attempt to experimentally determine if any of the antelopes (wild boks) found in the affected districts are subject to the malady. Probably none are susceptible as the disease is said not to have affected their numbers, but the question is well worth investigating by means of direct experiment.

Not all kinds of sheep and goats are equally susceptible to the disease. Dr. Edington, indeed, calls it a disease of "high bred sheep and goats." The Persian sheep has a reputation for thriving and multiplying despite the disease when other sorts fail. The common boer goat also has a name for resistance, yet when this animal is exposed on notoriously bad heartwater farms it soon dies out. Vete-

rinary Surgeon Dixon (see *Agricultural Journal*, vol. XV, page 791, 1899,) tells us of a case in which 55 boer goats from Bedford were exposed on heartwater veld in Fort Beaufort with the result that only twelve survived a month and of these half were dead at the end of five months. The common boer goat of the south-western districts has been used in many of my experiments and has proved uniformly susceptible, very few surviving the attack. The angora goat is thought to be fully as susceptible as any sheep. Perhaps it may be that all kinds of sheep and goats contract the fever sooner or later when exposed to natural infection, but that some kinds are better able to withstand it than others and acquire immunity through attacks that do not make them perceptibly ill.

Mention that calves began to do poorly when heartwater first appeared is made in an extract from a report by the Magistrate of East London, quoted on p. 33; and evidence to the same effect was given by Mr. J. Webb before the Cattle Diseases Commission in 1876 (see p. 39). There may be some association between some one of the several ills of calves in the south-eastern districts and heartwater; and it is planned during the coming season to infect young calves with pathogenic ticks from heartwater goats to determine if any ill effects follow.

[Since the preparation of the report, the Department has received a communication from the Colonial Bacteriologist in which it is intimated that horse-sickness of equines, and the "imapunga" disease of cattle, otherwise known as veldziekte and boschziekte, are identical with heartwater].

Severity of Heartwater.—Heartwater attacks young and aged animals alike and appears to be as severe amongst animals in good condition as amongst those that are thin and weak. In sections where it is well established most of the cases in large flocks are amongst young stock, but this is doubtless because the older animals have had the disease and have in that way become immune or tolerant to it. Young animals suffer as severely as old ones. The virulence of the disease is variable, however, and whereas on some long affected farms small stock can be farmed with a margin of profit, on others the flocks quickly diminish in size, the decrease from the disease

being greater than the natural increase. Sheep are still farmed at a place near Fort Beaufort, where the loss is between forty and sixty per cent. The reason for the greater virulence of the disease on one farm than on another can at present only be roughly conjectured. Experience gained in the experiments conducted during the last two years leads me to think that a non-fatal case is likely so beget non-fatal cases when naturally transmitted, and *vice versa*, a fatal case is likely to cause fatal cases. Working with ticks from animals which survived their attacks, I had in 1900 four non-fatal and two fatal cases; the two latter traced to a very sick animal. In 1901, working with ticks from fatal cases, I had, not counting a few animals purposely destroyed when in fever, twenty-five fatal cases and one non-fatal. The exception, it is interesting to note, was brought on by adult ticks from the 1900 fatal cases eight months after the ticks had fed; the long interval between feeding on the sick goats and on the one to which they gave the fever may have in some way modified the infection. Thus far in 1902 (to February 1st) there have been one fatal and three mild cases, all tracing to animals which survived their attacks.

It is a recognized fact that a small flock of sheep or goats may be run on heartwater veld with little loss from the disease when a large flock would suffer severely. This state of affairs is what we would naturally expect on considering the matter in the light of the experimental results of the past year. The tick is infectious only when from a sick or recently recovered animal and the infection is lost by it if not transmited to a susceptible animal during its own life; the infection, in other words, does not pass through the egg stage. A small flock feeds over a relatively large area and probably along with large stock or else for months at a time runs on veld that was not pastured to sheep or goats for some time previously. The animals do get infested by Bont ticks but by ticks that have more likely passed the last stage on large stock than on small. Hence the chance of any individual animal in a small flock becoming infested by a pathogenic tick is relatively slight compared to the chance of an individual of a large flock getting so infested for in the latter case practically all the ticks would come from small stock and

thereby the proportion of pathogenic ones amongst them would be relatively large. Moreover the more cases of heartwater, the greater the number of the pathogenic ticks on a given area and, consequently, veld bearing large flocks tends to get more and more intensely infected. Perhaps in the course of time every animal of a small flock that lives long enough contracts the malady but many will have abundantly provided for the maintenance or increase of the flock's numbers by reproduction.

Losses from Heartwater.—With the advent of heartwater sheep farming became unprofitable in district after district, and now only small flocks for slaughter purposes are to be found over large areas of what was once the best sheep country of the Colony. Probably millions of woolled sheep would be farmed on land now used for much less remunerative cattle raising or land actually standing idle and growing up to bush were is not for the disease. The falling off in small stock in the infected districts is very evident from census statistics, and for purposes of illustration the approximate figures for some of the districts have been culled from blue books and are here presented.

SHEEP, ALL KINDS.

	1865.	1875.	1891.	1899.
Albany	309,500	148,000	94,500	76,000
Alexandria	41,000	17,000	6,000	4,000
Bathurst	18,750	2,900	700	285
Peddie	54,000	27,000	19,000	19,000
East London	..	84,000	2,500	3,500
King William's Town ..	..	464,000	171,000	138,000
Fort Beaufort ..	210,000	49,000	134,000	145,000
Uitenhage	343,000	256,000	40,000	24,000
Humansdorp	97,000	123,000	94,000	66,000

East London and King William's Town both lost very heavily between 1865 and 1875, but I have not been able to get their figures for 1865. A severe drought in the early seventies may have been responsible for some decrease but probably not much. Cattle nearly doubled in numbers between the two dates in Albany. Humansdorp

lies farthest west of the infected districts and is only lately beginning to feel the dire effects heavily. It shows an increase between 1865 and 1875.

The statistics relative to goats are instructive and incidentally show the rise and quick fall in the numbers of the very susceptible angora in Albany.

	ANGORA GOATS			OTHER KINDS.		
	1865.	1875.	1899.	1865.	1875.	1899.
Albany	3 500	31,500	5,300	87,250	19,900	11,650
Alexandria	175	1,000	200	5,500	3,800	2,000
Bathurst	150	100	..	2,100	1,750	3,200
Peddie	400	1,500	3	37,500	17,600	30,000
East London	..	1,750	..	..	9,000	18,000
King William's Town ..	..	9,750	700	..	115,500	73,500
Fort Beaufort	3,500	16,500	25,000	47,500	20,500	7,250
Uitenhage	2,250	60,500	148,500	298,500	256,750	10,000
Humansdorp	160	2,200	3,750	14,000	9,200	9,200

Portions of Fort Beaufort, Uitenhage and Humansdorp, it must be remembered, are still exempt from the disease. The common goats in Peddie, King William's Town and East London are in small flocks, owned by natives. Peddie now has nearly as many goats as in 1865, and this fact may be an indication of superior hardihood towards the disease on the part of the goat bred there.

History of the Bont Tick.—Since the Bont Tick is the carrier of heartwater from animal to animal its history is of prime importance in tracing the origin and spread of the disease. An association of the tick with the disease was suspected by many coast farmers over a quarter century ago. Before the Cattle Diseases Commission, which sat in 1876-1877, Mr. J. Webb of the Albany district, when asked what he thought was the cause of small stock failing on what was formerly good pasture, gave evidence recorded as follows:—

"My opinion is we have a tick which made its appearance in the last eight or nine years. I suffered from them then, a bont tick, small like a lady bird. I was farming on a farm without ticks. Directly this tick appeared all my stock did badly. Calves died of gall-sickness and boschsiekte. One man lost 2,000 to 3,000 sheep and goats. I believe the tick caused it. I found water on the heart, caused by inflammation brought on by the tick. I have also shot bush bucks suffering from the same causes. This was at Southey's Poort, Fish River (Peddie district). As this tick increases, so

diseases increase, for wherever this tick is found there are the same diseases. The tick has now travelled over sixty miles. . . . I think I first saw the bont tick 14 or 15 years ago. . . . . The late Mr. W. Bowker told me he took one off a cow that came from Zululand about 40 years ago. This is the first known of them."

The question of where he had first seen the Bont Tick was also asked Mr. J. Bezuidenhout of Fort Beaufort by the Commission, and the reply on record is:—"In 1835, on the Gonubie, and also in Oliphant's Hoek about the same time." The late Mr. J. B. Hellier told me personally that the tick was recognized in Lower Albany (Bathurst) about 1835. His story was that Mr. Bertram Bowker was the first to notice it, he finding one on a cow at his father's farm. Oliphant's Hoek, mentioned by Mr. Bezuidenhout, is in Alexandria district, near the coast, and the Gunubie River is beyond the city of East London, over a hundred miles eastward in an air line. Bathurst and Peddie lie between. Hence it really seems as if the tick was in the country and spread over a considerable area long before heartwater began to menace the farming of small stock. C. L. Kock, a German scientist, described and figured the male tick in a work published in 1843. I do not know where he obtained his specimens, but he gave "South Africa" as the habitat. The range of the tick, now at least, extends eastward into Natal; Mr. Claude Fuller, above mentioned, recently wrote me that it occurs along the coast in that colony, though not, as far as his knowledge went, in excessive numbers. It is very probable that it extends much farther along the coast and that it was from some east coast source that the species spread southward into Cape Colony. A species of tick (*Amblyomma eburneum*), that is very much like the Bont Tick if not identical with it, is recorded from Mozambique and Zanzibar. Moreover a tick (*Ixodes poortmani*) that is considered identical (by G. Neumann in his recent "*Révision de la Famille des Ixodidés*") with the Bont is recorded from Cape Colony in 1850, on *Cynhyæna picta* (the wilde honde), and from the "Monts de la Lune" in 1861 on *Boselaphus oreas* (the eland).

The relative rapidity of the spread of heartwater before 1875 must, I think, have been due to the occurrence of the Bont Tick over a considerable area in advance. Infected animals had only to be brought

on to new veld to change the Bont ticks already there from comparatively harmless creatures into deadly instruments of disease. Moreover the number of cattle in the affected districts was increasing quickly about this time and doubtless served to greatly multiply the tick. By 1875 the malady appears to have caught up with the tick northward and westward, and since then tick and heartwater have encroached into new territory together. The tick spreads slowly. For over twenty years it and heartwater have infested farms an hour's ride west of Fort Beaufort, but to this day only an occasional male is seen on the farms twenty miles further west along the mountains. That it will thrive if left alone when it finally gets to these parts, I feel no doubt. Many farmers in Albany say that they never saw the Bont Tick until heartwater arrived. I believe them, but believe, too, that the tick was with them. The first English settlers of Albany did not see it when they took up their farms in 1820, although they then noticed other ticks. Hence, perhaps it was not in the Colony previous to about 1835, between when and 1840 it was seen in several places according to the evidence cited above. In Mr. J. Webb's evidence, it is distinctly stated that the cow bearing the ticks observed came from Zululand. The old roads used by the military and others from Algoa Bay into the Transkei extended through Albany, Peddie and King William's Town districts, and along them tens of thousands of trek oxen and loot cattle must have passed in the troublous days between 1830 and 1860. The Bont multiplies more rapidly on cattle than on small stock, and to the cattle brought out of the east may have been due its introduction and spread in the Colony. Certain it is that it was along the coast and up the river valleys from Algoa Bay eastward that the tick first became troublesome and even now occurs in greatest abundance.

Heartwater Introduction Theory.—We have thus far seen that heartwater spread out of the Peddie district in all directions about twenty-five years after the Bont Tick became known, and that the Bont Tick probably reached the Colony from the east coast. It may be profitable to speculate from whence came heartwater. I deem it highly probable that it, too, came from the east

coast. True we know of it nowhere outside of the Colony, but that fact cannot be taken as evidence of any value that it does not occur even along the whole coast northward of Natal. In support of the theory that it exists or has existed somewhere to the east and was introduced into the Colony in recent times can be brought a number of historical facts. Tradition has it that the Kafir races have pressed down from the east and north for centuries, that long ago they inhabited regions near the sources of the Nile, and history teaches us that when the first Cape settlements were made the Kafirs all abode beyond the Great Kei. The 1820 settlements extended to the Fish River and the country beyond that stream stretching to the Keiskama was reserved as neutral territory to prevent contact with the Kafir tribes. A few years before had began that sanguinary strife by which the mighty Chaka extended his dominion from an insignificant area west of Delagoa Bay to the immense tract from the Limpopo to Kaffaria. The destruction of a million human lives and the conversion of a hundred thousand square miles of territory into howling wilderness is laid to the accounts of this Nero-Napoleon of the Zulus. Whole tribes were annihilated and others fled southward, themselves becoming destroyers. Some of these tribes from the north sought to invade Kaffraria, and being repulsed took refuge with their victors for self-preservation. For several years they remained in virtual servitude. Meanwhile war ensued between the Kafirs and the English, and at its termination the subservient northern tribes, called Fingos, were offered a home on the neutral strip of land between the Fish and the Keiskama. From Butterworth and missionary stations beyond, the Fingos were gathered and 16,000 strong with 22,000 cattle and herds of goats they were brought down and located in the vicinity of Fort Peddie. The migration occurred in May, 1835, and occupied six days. Perhaps it was not until with them that the Bont Tick reached the Colony. For many years there seem to have been few white farmers in the vicinity of the locations. Indeed, until 1853, the Fish River was maintained as the eastern border of the Colony. Most of the farms towards the Keiskama, on the north-east, bear dates from 1854. Those towards the coast, East London and Bathurst divisions,

were taken up between 1858 and 1862; and those over the Keiskama in Ward 1, of East London, which were swept clean of sheep in the early seventies according to the magistrate's report given above, were settled in 1864. Now let Dr. Hutcheon's statement quoted above be recalled,—"*This disease was first observed amongst sheep and goats about 1860, near the coast on the borders of the King William's Town and Peddie districts, and from that centre it gradually spread north, south, east and west.*" Does it not appear that out of this land of Fingos, as soon as the country roundabout became settled, spread heartwater? And is it not likely that the Fingos brought the disease along from the east coast in their migration? In their small herds of hardy goats the ravages would have been slight and yet quite sufficient to retain the infection. They came down from Butterworth in six days, so that ticks could easly have been brought with them, and a single goat recently recovered from or about to come down with the malady could have carried the heartwater infection. An old account of the journey tells that some of the goats weakened and had to be carried. Very likely old natives are still to be found in Peddie who can throw light on the matter, and I hope these remarks will arouse interest and cause enquiries to be made. To some it may seem of no importance to ascertain how the infection got into the Colony; but let it be ascertained that it reached here in some such manner as suggested, that it did not originate in the country and therefore cannot be due to any peculiarity of the vegetation, soil or climate, and will not our farmers be more ready to discuss measures for its suppression?

Co-operation with Veterinary Branch. — When tick-heartwater work was first taken up, it was simply with the idea of assisting the veterinary branch by applying the experience I had gained in a study of the Bont Tick. Veterinary Surgeon Dixon was then, during 1899, engaged in investigating the disease and had determined that it was acquired on the veld independently of food and drink. He suspected the Bont Tick, and I suggested that it might be transmitted by nymphs or adults of this tick that in the previous feeding stage had been on a sick animal. With the view of testing the matter two

lots of nymphs were furnished Mr. Dixon, but both were lost in his attempts to rear them. Then Veterinary Surgeon Spreull who had worked with Mr. Dixon came to Cape Town, and it was suggested that we try with what remaining ticks I had on hand. Accordingly Mr. Dixon sent down two inoculated goats, and on these, during their illness, a number of nymphs were fed. These ticks later, as adults, were put on a healthy goat and gave rise to what at the time, December, 1899, was considered a probable case of heartwater. After that success, the work fell wholly into my hands and was prosecuted throughout 1900, with the result of demonstrating most satisfactorily that the Bont Tick was a transmitting agent. For 1901, there were planned experiments to test (1) ticks from recovered animals, (2) the progeny of pathogenic ticks, (3) common species of ticks other than the Bont, and (4) how long the infection persists in the tick when fed on non-susceptible animals.

Veterinary Surgeon W. Robertson arranged to study the disease technically from the cases produced in the experiments, and in return for his assistance in inoculating animals as I required and in making *post-mortem* examinations, I planned to aid him as far as possible in his phases of the work. His assistance was of great value, as, being a skilled veterinarian, his oversight removes any doubt one might hold that indisputable cases of heartwater were produced. Unfortunately the pressure of other veterinary work severely affected his researches, and in October he was obliged to drop the work entirely to go on rinderpest duty. Since his departure I have had to do such inoculation and *post-mortem* work as came up by myself and, luckily, all the deaths that have occurred have been from unmistakable heartwater.

The cost of the experiments have been charged to veterinary votes, and hence the experiments planned have been discussed with Dr. D. Hutcheon, the Colonial Veterinary Surgeon. He has been absent from the Colony during the latter half of the year, but during the early part he followed the experiments step by step, and occasionally assisted by personally attending to inoculations and *post-mortem* examinations. Mr. Dixon, too, has been interested, and to him was due the procural of the strain of fever with which the work was started.

Stable Accommodation.—To prevent confusion by ticks getting on to other animals than those for which they were intended, it was necessary to widely separate the animals used in different experiments. Several stables were therefore used. A new shed with three rooms was specially erected on the site of the proposed Supreme Court Building, which is convenient to the office. An old shed on the same site, in which last year's experiments were conducted, was also used but almost wholly for the infection of ticks on inoculated animals as, on account of ticks having been lost there, it was hardly safe for new work. At Rosebank near my home, a three stall stable and coach-house was rented and used for about seven months. When still other space became desirable, advantage was taken of a generous invitation from Mr. E. Pillans of the Department, to make use of outbuildings at his residence, Rosedale, Rosebank. Stanchions were put up in three separate sheds there; and in addition a cow on which pathogenic ticks were reared was kept for a few months in his cow-stable. The keeping of animals in so many places entailed a great deal of trouble, but not otherwise could experiments, involving as these did both pathogenic and non-pathogenic ticks in immense numbers, have been relied on to yield trustworthy results. Even with the precautions taken, there were a few accidental infections, as will be explained. The new shed in Cape Town has been used more than the other places. At first a dirt floor was deemed admissible, but dropped ticks were found to survive in the soil despite an occasional spraying with paraffin oil, and on this account a cement floor, that can be thoroughly cleansed, has been added.

Animals for the Experiments.—Fifty common goats for the work were purchased and used during the year. They came from Stellenbosch, Paarl and Wellington in the south-west of the Colony where heartwater does not exist. Some difficulty was experienced in getting them as they were wanted, a few at a time, owing to martial law in the country; and because of the scarcity of goats, a high price, from 18s. to £1 a piece, had always to be paid. All were horn marked, with consecutive numbers, as they were received. Many of the animals were in wofully poor condition, particularly Nos. XVII to XXVIII,

PLATE 6.

TICK-HEARTWATER RESEARCH.

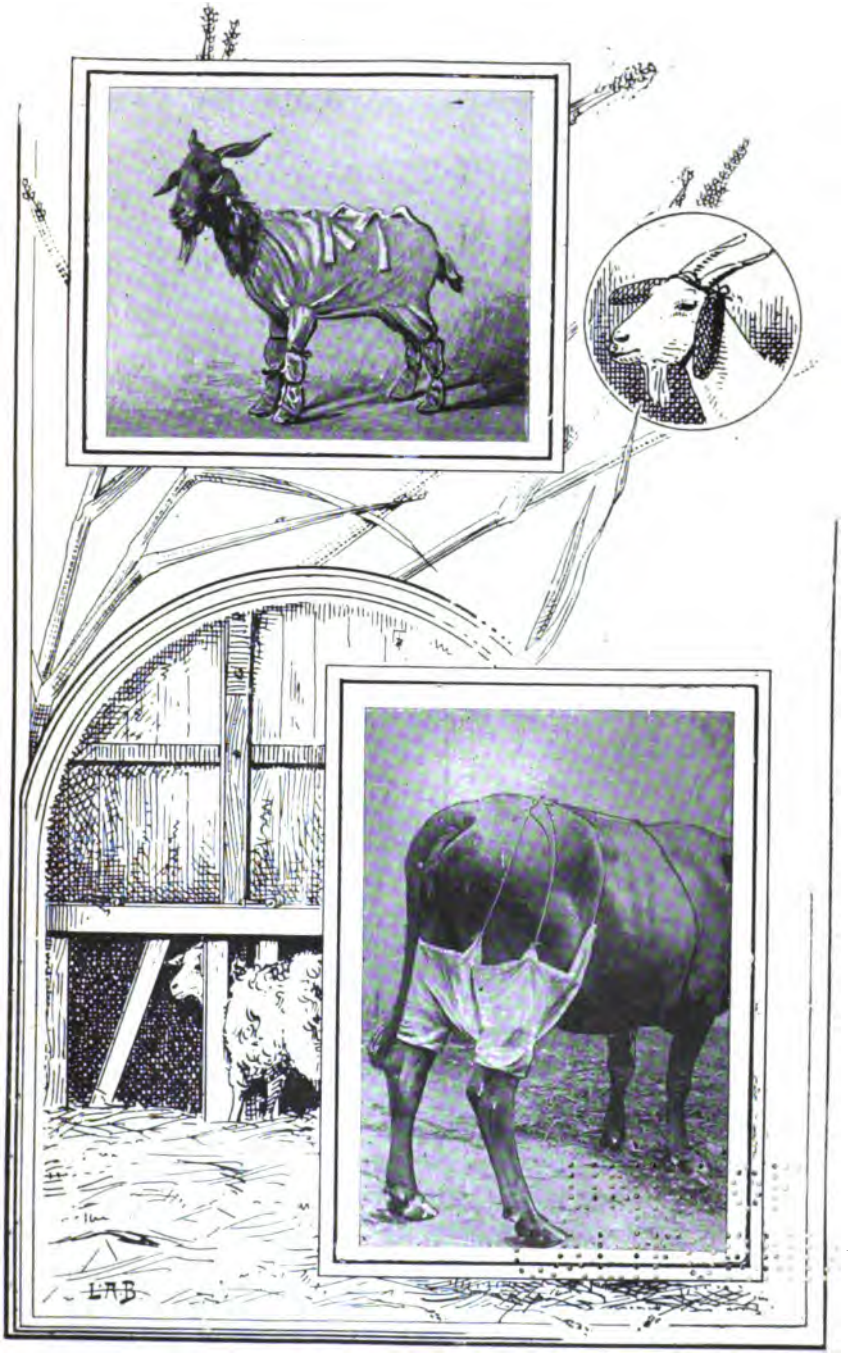
Goat clothed for application and recovery of any stage of the Boat Tick.

Cow with udder clothed for application and recovery of any stage of the Bont Tick.

Goat's head with ears covered for application and recovery of early stages of Red ticks.

View in shed with one goat in stanchions, and one open set of stanchions.

PLATE VI.



knees, and in four or more places along the back, the creature experienced little discomfort. Ewes were used in most of these experiments, and when the garments were properly adjusted to them there was no trouble from the passing of fæces or urine. Some modifications of the garment were necessary when male goats were employed. The ticks were liberated within the cloths. After four days, Bont larvæ and nymphs began to drop off engorged, and to get them uninjured they required to be collected two or three times a day. Sometimes all the ticks were off in eight or ten days, but usually the cloths had to be kept on two weeks or longer. When only a few ticks had to be applied and their recovery was unnecessary, the liberations were generally made in snugly tied stockings. These were made about thirteen inches long, with double feet, and with a puckering tape at the top. Red Tick larvæ attach freely only in the ears and for their application and recovery, ear caps tied together with tapes in front of the horns and over and under the neck were employed. Red Tick adults attach about the anus and vulva. The simplest and best way to apply them was found to be that of scattering them back of the animal when it was lying quietly. When the females were engorged, the bedding was removed and the ticks allowed to drop on to the bare floor where they were readily seen, or they were plucked off and destroyed if not wanted for future work. The cow required many garments during the three months she was in use. In her case only the udder was infested and the garments were not elaborate. At first she objected to wearing "pants" and speedily destroyed a few that had taken hours to plan and make.

Temperatures of Animals.—The temperatures of all the animals under experiment and those serving as checks were taken twice a day, once in the morning between six and eight o'clock and again in the afternoon between five and six; in addition a noonday reading of those in fever was usually taken. As temperature records of a number of typical cases of heartwater were given in the 1900 report, there seems no need to reproduce those of any of this year's goats. The body heat of a goat is subject to great fluctuations. The chief factor influencing

it in health is the external temperature, and on very hot days the noon and evening readings of the animals kept in the Cape Town sheds were always high. If hot nights followed hot days the morning readings were also unusually high. Sometimes the range during the day for a healthy goat was over five degrees (F.) The Rosebank stable was of brick and had a ventilated loft overhead, and the goats kept there almost always had lower temperatures than those kept in the corrugated iron sheds in Cape Town. The average normal temperature of adult goats in the cooler stable was about 101° in the early morning and about 102½° at sunset. Some goats were nearly always below the average and others above, even when of the same age and kept under the same conditions. One of the heaviest haired goats used in the experiments seldom gave a reading as high as 101° in the morning and on several occasions it brought the mercury only to 97½°; in the evening its average was 102°. This was during November and December in the hot Cape Town shed when its mates rarely had temperatures as low as 101° in the morning and 103° at sundown. Yet this goat was perfectly healthy at the time, and when it finally contracted heartwater its temperature ran up to 108°.

PART II.—EXPERIMENTS.

Experiments Resulting Positively.

The experiments resulting positively were all in the use of the Bont Tick, *Amblyomma hebræum* Koch; for this reason the name of the tick is omitted in the sub-headings.

A. Infection transmitted by Nymphs fed as Larvæ on sick Animals.—That nymphs of the Bont Tick fed on animals sick with heartwater were capable of transmitting the disease to susceptible animals was conclusively demonstrated in the 1900 series of experiments. More proof as follows was obtained during 1901, chiefly by the infection

of animals through this means whose susceptibility to the malady it was necessary to establish in order to prove the worth of previous negative tests :—

1. Animal No. VI, Boer ewe goat, received Dec. 25th, Cape Town stable. Infested Jan. 28th with 100 nymphs as larvæ from sick "ewe" Dec. 26th. Fever appeared on Feb. 8th and terminated fatally Feb. 13th
2. Animal No. VII, Boer ewe goat. Received Jan. 20th, Cape Town stable. Infested Feb. 11th with 5 nymphs as larvæ from sick goat Dec. 26th. Fever appeared Feb. 26th and terminated fatally March 1st.
3. Animal No. XII, Boer ewe goat. Received Jan. 20th, Cape Town stable. Infested March 5th with one nymph, as larva from No. IX sick Feb. 4th. Fever appeared March 19th and terminated fatally March 23rd.
4. Animal No. XVIII, Boer ewe goat. Received Jan. 20th, Cape Town stable. Infested March 27th with 32 nymphs as larvæ from No. IX sick Feb. 4th. Fever appeared April 9th and terminated fatally April 12th.
5. Animal No. XXV, Boer ewe goat. Received March 16th. Infested March 20th with 2 nymphs as larvæ from No. IX sick Feb. 4th. Fever appeared April 3rd and terminated fatally April 12th.
6. Animal XXXIII, Boer ewe goat. Received April 12th, Rosebank stable. Infested June 12th with 10 pathogenic nymphs June 12th. Fever appeared June 26th. Animal destroyed for its fevered blood June 28th.
7. Animal No. XXXV, Boer ewe goat Received Rosebank stable, April 12th. Transferred to Rosedale April 20th Infested April 28th with 10 pathogenic nymphs. Fever appeared May 9th and terminated fatally May 15th.

These records afford striking evidence of the transmission of the disease from sick to healthy animals through the agency of the Bont Tick in its nymphal stage. A single one of the tiny creatures proved quite sufficient to fatally infect a healthy susceptible animal (3). The virulence of the disease in all seven cases was very marked. In no case in which nymphs were applied, after they had fed as larvæ on a sick animal, has the fever failed to appear, neither in the 1900 experiments when ten goats were infected nor during the present year. The period from the application of the ticks to the detection of fever by the thermometer ranged from eleven to fifteen days with an average of thirteen and one-third days.

Still other evidence of the transmission of heartwater by nymphs is furnished by Mr. Dixon. On his return to his Somerset East headquarters in March last after an absence of some weeks, he found that his strain of infection had been lost. To enable him to get a new strain, I sent him pathogenic nymphs; and in May he wrote: "The Bont nymphs gave the fever all right and killed both goats infested."

B. INFECTION TRANSMITTED BY ADULTS FED AS NYMPHS ON SICK ANIMALS.—The very first test made in the tick-heartwater investigations was with adults fed as nymphs

or sick angora goats. A mild attack of fever followed (1899 Report, p. 24-27). The record of the only other test of the kind is as follows: —

1.—Animal No. IV, Boer ewe goat. Received Cape Town stable December 25th, 1900. Infested January 3rd with about 20 males and January 8th with 20 females, all from goats VII and VIII of 1900 series, as nymphs, when in fever April 23rd to 28th. Fever appeared January 18th, and its heart-water nature affirmed by the inoculation of VIII and IX. No. IV recovered, but both the inoculated goats succumbed.

Doubtless adults fed as nymphs on sick animals are quite as capable of transmitting the infection as nymphs fed as larvæ on the same animals. It is worthy of note that the adults infecting No. IV had had their nymphal feeding over *eight months* before; they moulted during July, and hence had been awaiting a host for about six months. The mild character of the infection they transmitted may have been due to the long delay in transmitting it.

C. Infection transmitted by Nymphs fed as Larvæ on recently recovered Animals.—The experiments under this head really belong to 1902, but they are inserted here for the sake of completeness.

1. Animal No. L, angora cross ewe goat. Received Cape Town stable, October 29th. Retained as check goat only until December 14th, when infested with nymphs from XLIV on November 11th. XLIV was a boer kapater that had been in severe fever (from blood inoculation) between October 20th and October 25th. Only two ticks were found attached to L on January 16th, and more of the same lot were applied January 16th. No recoveries were made until the 26th. In all 26 were recovered. Fever appeared December 31st, and terminated fatally January 7th.
2. Animal No. LI, angora cross ewe goat. Received with L and like it kept unused for several weeks. Infested December 13th with nymphs from XL on November 11th. XL was a boer ewe that had been in severe fever (from blood inoculation) between October 19th and October 29th. About 50 of these presumably pathogenic nymphs were applied December 13th, about 60 more December 17th, about 200 more, December 21st, and 100 December 28th. The first recoveries were made December 21st, and from then to January 11th about 375 were recovered. Fever appeared December 30th and ran a long low course until January 22nd. At no time was there lack of appetite or other external symptoms of illness.

Evidently Bont nymphs from recently recovered animals convey the disease. The fact that the blood of such animals is virulent has, I believe, been recently shown by Mr. Dixon. The fever of LI was peculiar by its extreme length and its low readings. Perhaps its length was due to the successive applications of the infective ticks as the date of the final subsidence is about the time one would have expected its cessation from the last applied ticks. The incubation period of the fevers in both L and LI, 17 days, is unusually long. Probably both XL

and XLIV were both losing the capacity to infect ticks when those used were recovered. A test of ticks from XL on December 2nd is in progress at the time of writing. [This test resulted negatively, thus demonstrating that the recovered animal soon lost its capacity to infect others.]

D. INFECTION TRANSMITTED BY ADULTS FED ON COW AS NYMPHS BUT ON SICK ANIMALS AS LARVÆ.—The object of this series of experiments was to ascertain if the infection could persist in the tick over a feeding stage. Positive results were so unexpected that the test was thrice repeated. The larvæ used were dropped by dying heartwater goats. Soon after they moulted to the nymph stage they were fed on the cow; and then after having moulted again they were tested on the susceptible goats. The cow did not appear to become affected although many thousands of the nymphs were fed on her.

1. Animal No. XI, Boer ewe goat. Received Cape Town stable Jan. 20th. Previously used in L2 experiment. Infested March 13th with 20 males from cow February 9th and from dying "kapater," as larvæ, December 29th. Fever appeared April 3rd and terminated fatally April 7th.
2. Animal No. XIII, Boer ewe goat Received Rosebank stable, February 19th. Previously used in N experiments. Transferred to Rosedale March 28th and infested with 20 males to which 20 females were added April 3rd; all from cow February 9th and from dying "kapater," as larvæ, December 29th. Fever appeared April 17th and terminated fatally April 19th.
3. Animal No. XIX, Boer ewe goat. Received Cape Town stable February 19th. Infested March 5th with 20 males from cow about February 9th and from dying "kapater", as larvæ, December 29th None seen attached until March 7th. Females applied March 21st. Fever appeared March 22nd and terminated fatally March 23rd.
4. Animal No. XXIII, Boer ewe goat. Received Cape Town stable March 16th. Infested March 19th with 20 males from cow about February 9th and from dying "kapater," as larvæ, December 29th. Fever appeared April 6th at night and goat found dead on following morning. *Post-mortem* examination not entirely conclusive of heartwater, yet fever was appearing when it was looked for and no other explanation for death was suggested. Animal was very thin but had been feeding all right.
5. Animal No. XXVI, Boer ewe goat. Received Cape Town stable March 16th. Infested March 23rd with 20 males and 20 females from cow about February 9th and from dying "kapater," as larvæ, December 29th. No females attached until March 30th. Found dead morning of April 13th after a temperature reading of only 104° on previous evening and 100·7 previous morning. *Post-mortem* examination showed heartwater, yet appearances were not wholly typical. The animal had been in poor condition and had suffered from diarrhœa for ten days before death. If death was from heartwater the adult ticks may not have been responsible as on March 27th the test was vitiated by the finding of a stray nymph in the cloth garment.
6. Animal No. XXIX, Boer ewe goat. Received Cape Town stable April 12th. Infested April 13th with 20 males from cow in March and from dying IX, as larvæ, February 4th. Nine ticks only attached. On May 14th, 12 females were applied. Fever appeared May 24th and terminated fatally May 26th.

7. Animal No. XXX, Boer ewe goat. Received Cape Town stable on April 12th. Infested April 13th with 25 males from cow in March and from dying IX as larvæ. Only 8 attached. Fever appeared May 2nd and death occurred May 6th.
8. Animal No. XXXI, Boer ewe goat. Received Cape Town stable on April 12th. Infested April 13th with 25 males from cow about February 9th and from dying "kapater" December 29th. The attachments by the 22nd numbered 20. Animal became feverish May 6th and aborted May 8th. On the 14th the temperature was again normal. Twelve females applied on May 14th. Fever appeared on May 25th and terminated fatally May 28th.
9. Animal No. XXXII, Boer ewe goat. Received Rosebank stable April 12th. Previously used for N experiment. Infested May 8th with 30 males from cow during March and dying IX as larvæ; and on May 12th 30 females were added. Fever appeared May 25th and terminated fatally May 28th.
10. Animal No. XXXVII, Boer ewe goat. Received Cape Town stable June 12th. Previously used in O experiment. Infested July 15th with large number of males from cow during March and from dying IX as larvæ. About 50 attached. Females to about an equal number applied July 22nd. Fever appeared August 10th and terminated fatally August 13th.
11. Animal No. XLV, a large wether that had been in Cape Town shed for about two months. Heavily infested September 9th and 10th with males from cow in April and, as larvæ, from IX when dying in early February. Numerous females applied September 13th, 19th, 21st and 27th. Total recovery 28 engorged females. Fever appeared October 8th and from then until October 16th the thermometer readings averaged 106·6; on the latter date the animal was killed to end its misery.

This series of experiments shows very well that ticks from cattle may transmit the disease to susceptible animals, if as larvæ they fed on fevered blood. Cattle then may carry the disease into new areas.

From the records of the experiments, it appears as if many of the ticks fed on the cow, both males and females, must have lost their capacity to infect. Without assuming that many did the long interval in some of the cases between the application of the ticks and the on-set of fever cannot be explained. The infection transmitted, nevertheless, was very virulent. The impression left with me was that few of the males were pathogenic. Male Bont ticks, unlike larvæ and nymphs, are very slow about attaching to a goat or sheep unless they have been awaiting a host for several weeks. When a dozen or twenty were applied at once as in most of these tests, two or three only would generally be found attached within twenty-four hours and sometimes none would be on for two days or more; then day by day more would take hold. The female Bonts very rarely attached until males had been on four or five days and had become amorous; then they took hold at once. If females were applied before they could find partners, they were very apt to leave that animal to search over others for company, and

thus introduce elements of confusion into the experiments; it was to obviate this risk as far as possible that the males were generally applied several days in advance. A score of females may cluster about a single amorous male.

Cases 9 and 10 (Animals XXXVII and XLV) were produced when no other experiment involving the use of pathogenic ticks was being conducted, and when no pathogenic ticks other than those from the cow were on hand. Mr. Robertson needed a case of heartwater for his studies and XXXVII was infected to provide him with one. The old sheep was infected two months later for the purpose of engorging females from which to get material for 1902 work and to incidentally affirm that sheep can be infected by ticks made pathogenic through feeding on goats.

Ticks of the same lot as those used in the first few cases were sent to Mr. Dixon. Later he reported, "With the adult Bonts you sent me I infected two goats. One became very ill but recovered; the other on which I could only get one male to fix himself gave no reaction. Since I have found the latter to be susceptible.

E. Infection transmitted by Adults fed on long recovered Goat as Nymphs but on sick Animal as Larvæ.—This experiment was very similar to those recorded under D, but with a long recovered goat (66 B, ill in early part of December, 1900,) substituted for the cow.

1. Animal No. XXXVI, Boer kapater goat. Received Cape Town stable, June 12th. Previously used for O experiment. Infested July 11th with 12 males from long recovered goat 66 B April 3rd, and as larvæ from dying IX goat in early February. 15 females of same lot added July 17th. Fever appeared August 4th and terminated fatally August 10th. The infection must have come from the larval feeding on IX as non-pathogenic larvæ fed on 66 B at same time failed to transmit fever.

This experiment shows that while long recovered (that is salted) animals are not directly a source of infection (see N series) they may like cattle carry the disease into new areas by being bearers of ticks made pathogenic by having fed on infectious animals as larvæ.

F. Infection transmitted to recovered Animals by Pathogenic Nymphs.—In experiments which will soon be described it was found that no infection arises from long recovered animals in normal temperature. It was then

conjectured that such animals might have lost their immunity, and to test the matter the four recovered animals on which ticks had been reared were subjected to infestation by virulently pathogenic nymphs.

1. Animal 61 A, Angora ewe goat from Veterinary Surgeon Dixon, Somerset East, January 25th. Had had severe fever from October 17th to 30th, 1900. Infested March 17th with pathogenic nymphs from dying IX. 49 became engorged. The temperature rose to 106° on the thirteenth day and remained high until the nineteenth (March 20th-26th); then the fever subsided. At no time was any lack of appetite or symptom of discomfort manifested, and had it not been for the abnormal temperature no illness would have been suspected.
2. Animal 66 B, Angora ewe goat from Veterinary Surgeon Dixon, Somerset East, January 25th. Had had severe fever December 12th to 23rd, 1900. Infested March 27th with pathogenic nymphs from dying IX. 43 became engorged. Fever became evident by the temperature on April 9th, the thirteenth day, and continued until April 16th; the maximum temperature was 106·1° for the morning and 106·2° for the evening. As with 61A there were no indications of illness in the general appearance and behaviour.
3. Animal C, old Angora ewe goat from farm Hammonds, Fort Beaufort, February 12th. Was said to have had severe fever some years ago and came direct from heartwater veld. Infested during April with several dozen pathogenic nymphs. Unfortunately the temperature records were destroyed, but it was recorded that very little reaction if any was given, no reading being above 104°. On May 13th 25c.c. of virulent blood was injected into the jugular but again the reaction was scarcely perceptible, no reading during the critical period being above 103·6° in the afternoon and only one reaching 103° in the morning.
4. Animal D, old Angora ewe goat from farm Hammonds, Fort Beaufort, February 12th. This goat was No. 1 in the 1900 experiments and had had a mild attack of heartwater at Cottesbrook in February of that year. From then until sent to Cape Town it had been pastured on heartwater veld. Like C it was infested with numerous pathogenic nymphs during April with the result of causing only slightly abnormal temperatures. On May 13th 10 c.c. of virulent blood was injected intravenously, and again there were slightly higher readings than were normal for the animal about the time fever was expected; yet the maximum morning temperature was 102·8° and the maximum evening temperature 103°. Neither this goat nor C showed illness by lack of appetite or appearance.

It is not safe to draw definite conclusions from these few tests; but it appears as if animals which recover from heartwater still remain subject to infection and that their resistance when kept exposed to re-infection strengthens with time. One of the experiments planned for 1902 is to test ticks dropped by recovered goats during a period of pronounced secondary fever. It may be that such ticks are pathogenic but give rise to a milder attack than ticks from sick animals.

Experiments Resulting Negatively.

The experiments resulting negatively were conducted with the Bont Tick (*Amblyomma hebræum* Koch), the Red Tick (*Rhipicephalus Evertsi* Neumann,) and the Blue Tick

(*Rhipicephalus decoloratus* Koch). The last-named tick has very close affinities with *Rhipicephalus annulatus*, Say (the *Boophilus bovis* Riley, of many writers), and in the near future may be authoritatively connected with that species; it presents, however, some uniform structural differences. The life cycles and habits of the two species are very similar if not identical.

L. THE BONT TICK IS NORMALLY NON-PATHOGENIC.—Perhaps no scientist would suspect this tick or any other of communicating a specific and often fatal disease like heartwater by its simple bite; but as many farmers believe the tick actually *causes*, and not alone transmits the malady, it was considered advisable to infest a susceptible animal with presumably non-pathogenic Bont ticks as a test case.

1. Animal No. VI, Boer ewe goat. Received December 25th Cape Town stable. Heavily infested January 3rd and again January 18th with Bont larvæ reared from females taken from an ox. Recovery estimated to number much above 5,000. Perfectly normal temperature prevailed throughout the critical period. Then to prove the animal susceptible to heartwater it was infected by pathogenic nymphs. (See first case in A series above.)
2. Animal No. XI, Boer ewe goat. Received at Cape Town stable January 20th. Infested February 13th with about 100 non-pathogenic nymphs from VI. Recovery counted 90. No fever produced and to prove animal susceptible it was later infected with pathogenic adults. (See D series, first case.)
3. Animal No. XII, Boer ewe goat. Received Cape Town stable January 20th. Infested with non-pathogenic nymphs from VI on February 13th. About 75 recovered. No fever produced, and to prove animal susceptible to the disease it was later infected with a single pathogenic nymph. The result was a fatal attack. (See A series, case 3.)

No further proof than is afforded by these tests is necessary to prove the species normally innocuous so far as heartwater is concerned, but the following series is corroborative:

M. THE PROGENY OF PATHOGENIC BONT TICKS APPEAR NON-INFECTIOUS.—All the cases of heartwater transmitted by ticks have originated from the attack of ticks that at an earlier stage in their own lives had fed on animals sick with or recently recovered from the disease. This series of tests was to ascertain if the infection could pass from one generation to another.

1. Animal No. VII, Boer ewe goat. Received Cape Town stable on January 20th. Infested same day with 1,000 or more larvæ from eggs laid by two females taken from No 3 goat of 1900 series on the first day of its fever. At least 600 larvæ became engorged but no fever resulted. The animal was later proved susceptible by the fatal termination of fever resulting from 5 pathogenic nymphs. (See A series, case 2.)

2. Animal No. XXXIX, Boer kapater goat. Received Cape Town stable June 12th. Previously used in O series. Infested August 26th with larvæ from females taken off XXIX when dying, May 25th. 220 recovered. More larvæ of same lot applied September 13th. 58 recovered. No reaction at all followed. Animal proved susceptible in November by inoculation of virulent blood.
3. Animal No. XLII, Boer kapater goat. Previously used in Q series. Infested September 6th with larvæ from females taken off XXIX when dying May 25th. 315 recovered. No reaction. In November animal proved susceptible by inoculation of virulent blood.
4. Animal No. LIII, Angora cross ewe goat. Received at Cape Town stable, October 29th. Infested October 30th with larvæ reared from females taken off XXXIII when destroyed at height of fever June 28th. 1,390 recovered. No reaction.

Late in the year the thought occurred to me that even if the larvæ from pathogenic mothers are non-pathogenic it would not necessarily follow that the infection has failed to persist; the larva might contain the infection but be unable to transmit it. It was therefore considered advisable to test nymphs reared from larvæ out of pathogenic mothers.

1. Animal No. LII, Angora cross ewe goat. Received at Cape Town stable, October 29th. Infested October 30th with nymphs from larvæ recovered from XXXIX about September 2nd. 110 recovered. No reaction. Infested December 16th with nymphs from larvæ recovered from LIII about November 10th. More applied at intervals to December 28th. 96 recovered. No reaction whatever.

Evidently the nymphs either had no infection to transmit or were incapable of transmitting it if they had any. In experiments with malignant jaundice of the dog, it was discovered that the infection lay over in the transmitting tick from adult stage to adult stage, the larvæ and nymphs being incompetent to transmit the infection they possessed. Not knowing but that some similar retardation might occur in the transmission of heartwater by the Bont Tick when the infection was taken up by the adult stage, it was decided to try adults descending from females off of fevered animals.

1. Animal LIII, used in first section of this series. Infested December 12th with males from LII as nymphs, and from XXXIX as larvæ, and tracing to females taken off dying XXIX. 17 attached. Females applied December 17th and in a few days eight attached. No reaction.
2. Animal LVI, angora cross ewe. Received at Cape Town stable, December 18th. Infested December 21st with 15 males of the same lot as those applied to LIII. All attached, and in December 27th, 15 females added. No reaction.

Evidently the tests with which the ticks were conducted were absolutely non-pathogenic. We may safely conclude at least that it is unusual, if not impossible, for the infection of heartwater to be transmitted from one generation of ticks to the next. Redwater in cattle and malignant jaundice in dogs are transmitted by the progeny of ticks from

infective animals, but thus far no one has discovered how the organisms of the disease gain access to the eggs. It may be that the organism enters in the spermatozoa from the male parent and if such were the case the progeny would be non-pathogenic unless the male had fed on diseased blood before it mated. Mating may occur some days before the Bont tick female is replete with blood; and therefore the females from which the progeny used in the experiments were reared may and indeed probably did only have sperms received prior to the fever period. Yet even if the remote possibility that the progeny of females off heartwater goats may under some circumstances inherit the parents' capacity to infect is a fact, it is unlikely that many cases of the disease are thus produced.

A few tests were made to determine if the capacity to infect persists in the progeny of Bont ticks which, pathogenic as larvæ, are fed during the subsequent nymphal and adult stages on a cow. In the D series of tests, it is shown that the adults possess the infecting property.

1. Animal No. XL, Boer ewe goat. Used in Q series during June. Infested on September 19th with large numbers of larvæ reared from females off cow in May, fed as nymphs on cow during February, and as larvæ on dying "ewe" about January 1st, 1901. Only 47 recovered but probably large numbers fed. No reaction. Animal afterwards proved susceptible through the inoculation of diseased blood.
2. Animal No. XLII, Boer kapater goat. Used in Q series during June and in the first section of this series in early September. Infested on October 10th with larvæ of the same lot as these applied to XL. 70 recovered. No reaction. Animal soon afterwards proved susceptible by the inoculation of virulent blood.
3. Animal No. XLIV, Boer kapater goat. Used before in R series. Infested August 28th with large numbers of larvæ with same history as those used on XL and XLII. 94 recovered. No reaction. Animal later proved susceptible by its contracting fever through inoculation.

Eggs from a number of ticks which were pathogenic from feeding as larvæ on IX during its fever and were fed on the cow as nymphs and on No. XLV as adults are hatching at the time of writing; and it is proposed to try the larvæ of the new generation to secure additional evidence. Animal XLV succumbed to the attack of the parent ticks.

N. Bont Nymphs from long recovered Animals either transmit only very mild Infection or none at all.—It is unfortunate that heartwater cannot be reliably diagnosed. The only way of proving a case of mild fever is by testing the infective capacity of the blood and this is

probably a far from satisfactory way in many cases, since only very mild cases or none at all could be expected. Practically, mild cases are probably of little importance as, so far as known, they confer little if any immunity or tolerance towards subsequent infection. The following experiments leave it rather doubtful that any infection is transmitted to susceptible animals by nymphs which as larvæ fed on animals recovered three months and longer. The history of the recovered animals on which the ticks were fed is given under F series of experiments.

1. Animals No XIII, Boer ewe goat. Received Rosebank stable on Feb. 19th. Infested Feb. 20th with Bont nymphs from 61A as larvæ about Feb. 1st: 80 engorged and were recovered. Infested Feb. 26th with more of same lot of ticks; 207 engorged and were recovered. Infested for the third time on March 10th, with Bont nymphs from C as larvæ on Feb. 17th; 42 engorged and were recovered. The critical period for the first lot of ticks passed without any perceptible fever, no temperature reading for morning or night was above 103°. From the 13th day to the 31st day (March 11th to 28th) from the second lot, however, the readings average 1·6 above the average for the earlier period. With the exception of a few odd instances, the readings were fairly uniform between the two dates. The average for the morning was 102·7° and for the evening 103·4°. The animal ate heartily and appeared perfectly well. On March 28th it was removed to Rosedale and infested with pathogenic adult ticks with the result of transmitting fatal heartwater. (See D series, case 2.)
2. Animal No XIV, Boer ewe goat. Received February 19th at Rosebank stable Infested on February 20th with Bont nymphs from 61A as larvæ about February 1st; 88 fed and were recovered. Infested on March 10th with Bont nymphs from D as larvæ on February 19th: 208 fed and were recovered. Normal temperatures prevailed up to March 28th, when animal was removed to Rosedale and infested with pathogenic adult ticks. Before these ticks had time to give rise to fever the animal was taken with fever and died on April 2nd.†

† NOTE.—There is no probability whatever that the infection came from the ticks purposely applied. Instead, I have no doubt that this goat and No. XVI were infected by stray ticks. At the time I had many thousands of pathogenic ticks on hand and through an accident which is worth describing a large number of these escaped. Ten thousand or more of the ticks were in a large thin glass beaker. On the night of March 15th I took this to Rosedale and liberated many hundreds on the cow kept there for the D series of experiments. In my haste to tie up the "pants" within which the ticks were let loose, I set the dish down rather heavily and then, I suspect, broke a piece from the bottom. Darkness was closing in and without noticing any break, I wrapped the glass in several thicknesses of paper and hurried away. On arriving at home, I placed the package in the wood-box for safety. Quite ignorant of the accident, I visited the Rosebank goats early the following morning. It was my custom to change my clothes before working with animals in the different stables but that morning, being in a great hurry and having much to do, I neglected this precaution and simply pulled an old pair of trousers over those I had on. After taking temperatures, I worked sometime over goats XIII, XIV and XVI, removing their garments and collecting ticks that had dropped. During the day I was puzzled to see a Bont nymph crawling on my coat, and on examining closer half-a-dozen were found. When I reached home I found more crawling over the papers about the glass beaker in the wood-box, and then the chipped bottom was discovered. Naturally, knowing that a single one of the ticks could transmit the fever, I feared having accidentally infected XIII, XIV and XVI; and before the incubation period of fever from an infection on that date would lapse, I removed these three animals from the stable, which I then desired to keep free of infection, to a shed at Rosedale. The fears proved well-founded, XIV and

XVI manifesting the fever and dying as recorded. Hungry Bont ticks are very active creatures and hundreds had found the small break in the glass beaker and had contrived to make their way out through the enclosing papers. All that could be located about the wood-box were destroyed and the crevices of the box saturated with oil. At the time I imagined I had killed all that escaped there, but after events indicated otherwise. For over six months odd specimens kept turning up about the house and on the persons of members of the family. It might be thought that these were later escapes, but I am quite sure they were not. Not only was I particularly careful about the ticks after that, but the specimens found shewed by their appearance that they had been waiting long for a host.

3. Animal No. XVI, Boer ewe goat. Received at Rosebank stable February 19th. Inoculated with 10 c.c. blood from 61A February 20th. No effects became evident. Infected March 10th with Bont nymphs from D as larvæ on February 19th. 74 fed to repletion. On March 28th removed animal to Rosedale and infected it with pathogenic adults; before these had time to act fever appeared and caused death on April 4th. (See foot note to case 2.)

4. Animal No. XVII, Boer ewe goat. Received Cape Town stable, February 19th. Infested February 21st with Bont nymphs from 61A as larvæ about February 1st. 127 fed and recovered. On March 15th again infested from same lot of ticks; 512 fed and were recovered. No rise of temperature was produced. Animal was in very poor condition when received. The dry forage appeared to disagree with her and about March 13th she began to suffer from diarrhœa; by the 21st she was too weak to stand and refused food. Her temperature became subnormal, and on the morning of 25th she was found dead. The *post-mortem* revealed no indication of heartwater but was confirmatory of death being due to dietetic troubles. Several other goats, including three not used at all in the experiments, succumbed to similar troubles; in none of the cases was there the least suspicion of heartwater.

5. Animal No. XXII, Boer ewe goat. Received Cape Town stable February 19th. Removed to Rosebank, March 7th. Infested March 10th with Bont nymphs from C as larvæ on February 17th. This was a poor animal which when received was suffering from a caked udder and which developed diarrhœa almost at once. By gruel and brandy it was kept alive until it became evident that no heartwater was transmitted. Death from dietetic troubles took place March 28th.

6. Animal No. XXXII, Boer ewe goat. Received Rosebank stable April 12th. Infested April 13th with Bont nymphs from C as larvæ February 17th. 178 fed and were recovered. Animal aborted April 24th, and for three days the temperature was slightly above normal. After this accident the health was good and temperature normal up to May 8th when pathogenic adults were applied. Fatal fever was thus produced. (See D series, case 9.)

7. Animal No. XXXIII, Boer ewe goat. Received at Rosebank stable on April 12th. Infested April 13th with Bont nymphs from D as larvæ on February 19th. 89 fed and were recovered. Almost uniform temperatures for both morning and evening prevailed throughout the critical period. Transferred to Rosedale June 1st and on June 12th infested with pathogenic nymphs; fatal fever followed (See A series, case 6.)

8. Animal No XXXIV, Boer ewe goat. Received at Rosebank stable April 12th Infested April 13th with Bont nymphs from D as larvæ on February 19th. 85 fed and were recovered. Fever appeared April 27th and terminated fatally April 29th. (This is presumed to have been a chance infection from a stray pathogenic tick.)

9. Animal No. XXXV, Boer ewe goat. Received at Rosebank stable April 12th. Aborted April 15th. Was in such poor condition that was not purposely infested, but was placed next to XXXII, these animals being well removed from all others. Watched for ticks and 12 located in hoofs; these were undoubtedly strays from the companion goat which had Bont nymphs as larvæ from C on February 17th. No indication of fever through critical period. Removed to Rosedale April 20th. Infested April 28th with pathogenic nymphs, and from these fatal heartwater contracted. (See A series, case 7.)

From these tests it is perfectly safe to conclude that recovered goats soon lose the capacity to seriously infect other animals. Nor does any tolerance to the disease appear to be transmitted by ticks from recovered animals as the animals succumb when later infested with pathogenic ticks. When the first goats, XIII, XIV and XVII, were infested, it was quite expected that fever would result notwithstanding that Veterinary Surgeon Dixon had found that the blood of recovered animals was innocuous; and to show the difference, if any, between the effects of ticks and blood from the recovered animal, three other goats were inoculated intravenously on the day, February 20th, that the ticks were applied. Animal XV received 5 c.c., animal XVI received 10 c.c., and animal XVIII, 15 c.c., drawn from animal 61 A, the goat on which the ticks had been reared. No fever at all was produced, and XVI and XVIII at least were afterwards proved susceptible, both dying from heartwater. For a short time after the cessation of the fever, Bont ticks, and likewise blood, are pathogenic. (See C series of experiments.)

O. BONT TICKS DROPPED DURING MOST OF THE INCUBATION PERIOD ARE HARMLESS.—This experiment was to determine what menace animals coming down with heartwater are to a flock. Non-pathogenic Bont larvæ were applied to animal XVIII at the same time infective nymphs were applied, and the larvæ dropped on different days during the incubation period were kept apart.

1. Animal No. XXXVI, Boer kapater goat. Received Cape Town stable June 12th. Infested June 17th with Bont nymphs dropped by XVIII, as larvæ on April 2nd, eight days before its rise of temperature. 63 fed and recovered. No indication of fever resulted, and on July 11th, goat infested with pathogenic adults and thus proved susceptible; see E series.
2. Animal No XXXVIII, Boer kapater goat Received Cape Town stable June 12th. Infested June 15th with Bont nymphs dropped by XVIII, as larvæ on April 8th, two days before its rise of temperature. Ten fed and recovered. No fever resulted, and on Aug 7th, goat inoculated with virulent blood from XXXVI, and thus proved susceptible.
3. Animal No. XXXIX, Boer kapater goat. Received Cape Town stable June 12th. Infested June 15th with Bont nymphs dropped by XVIII, as larvæ between morning of April 9th and morning of 10th when the rise of temperature was beginning. (It is difficult to place exact time the fever began in XVIII as her temperature was erratic ordinarily, but the reading for April 9th p.m. was 104·6°, for following morning 103·7°, and for the evening 105·1°. She died during the night of the 11th.) Ten fed and were recovered. No rise of temperature taking place more ticks of the same lot were applied

July 8th and of these fourteen were recovered after feeding. Still no indication of illness appeared and after being used for other experiments, the animal was inoculated November 4th with virulent blood and thus destroyed.

4. Animal No. XXXVII, Boer ewe goat. Received at Cape Town stable on June 12th. Infested on June 17th with Bont nymphs dropped by recovered goat 66B on April 10th just as its temperature was rising from the application of pathogenic ticks. Six recovered. No fever resulted and later shown susceptible in D series by the application of pathogenic adults.

These experiments show that ticks dropped practically up to the beginning of the fever are harmless. But ticks that have dropped during the first day of fever have been found pathogenic and it is probable that most animals are ill for a day or more in a flock before their condition is discovered. At my suggestion the Veterinary Department tested blood drawn during the period of incubation. Mr. Spreull did the work and found that 5 c.c. of blood drawn full twenty-four hours before the thermometer showed fever conveyed a fatal case when injected intravenously. Ten c.c. of blood drawn the previous day and injected intravenously into another animal proved innocuous.

P. BONT TICK MALES TRANSFERRED FROM A SICK TO A SUSCEPTIBLE ANIMAL SEEM INNOCUOUS.—The following experiment appears to indicate that the Bont Tick plays more than the part of a mere mechanical transmitter of the infection of heartwater.

1. Animal No. XXXIX, Boer kapater goat. Previously used in series O in June, and series M in August and September. Stood next to No. XLV during the latter's fever. On October 9th, after XLV had been in high fever for twenty-four hours the ticks which were attached to it were pulled off and liberated in a stocking on one of XXXIX's feet. The specimens were all males and were part of the lot which had infected XLV. Many were injured in detaching them but eight succeeded in taking hold and of these five were still on up to the twelfth day. No fever resulted. Animal proved susceptible, in November, through inoculation with blood.

Thus five or more adult ticks taken direct from a fevered animal failed to transmit any infection, a remarkable failure if direct transmission by means of ticks is normal. A single nymph which as a larva fed on a sick animal, it should be recalled, transmitted fatal infection; see A series, case 3.

Q. RED TICKS ARE NON-PATHOGENIC.—All the experiments with the Red Tick have been the testing of adults fed as nymphs on sick animals. The Red Tick does not drop as a larva and hence to get engorged nymphs from sick animals, hungry larvæ must be applied. The larvæ

feed freely only in the ears and need to be liberated in those appendages at least fourteen days before fever is expected. A test with a single goat made in 1899 indicated that the species does not transmit the disease. Another test, with four animals in 1900, left the issue doubtful for, although no definite fever was produced, abnormal temperatures prevailed after the application of the ticks. The 1901 experiments with the species remove the doubt and tend to show quite clearly that the Red Tick is not a factor in heartwater.

1.—Animal No. XL, Boer ewe goat. Received Rosebank stable June 12th. Infested June 15th with Red adults from XXXV when dying May 14th. 22 attached and remained until the 10 females of the number became engorged. No suspicion of fever produced. Removed to Rosedale in August and later proved susceptible through inoculation of virulent blood.

2. Animal No. XLI, Boer ewe goat. Received Rosebank stable June 12th. Infested June 15th with Red adults from XXXV when dying May 14th. 64 attached and remained; 30 females engorged. No suspicion of fever produced. Removed to Rosedale in August and later proved susceptible through inoculation with virulent blood.

3. Animal No. XLII, Boer kapater goat. Received Rosebank stable June 12th. Infested June 15th along with XLI. Only four ticks, all males, attached. No suspicion of fever produced. Removed to Rosedale in August and later proved susceptible to heartwater through inoculation of virulent blood.

4. Animal No. XLIII, Boer kapater goat. Received Rosebank station June 12th. Infested June 15th along with XL. 15 attached. No suspicion of heartwater produced. Removed to Rosedale in August and there proved susceptible when inoculated with virulent blood.

The progeny of the Red Tick when fed on heartwater animals might be tested but it is highly improbable that heartwater is transmitted in such a way by this tick when it is not by the Bont species.

R. Blue Ticks are Non-pathogenic.—The Blue Tick goes on its host as a larva to stay there until as a male it is exhausted and ready to die, or as a female is replete with blood. Consequently if the species is a factor in heartwater transmission, the infection must pass through the egg stage. The females take three weeks or more to arrive at their full growth and to get specimens fed on heartwater blood proved some trouble. Several times heavily infested animals were given the disease only to die before the ticks were ready to come off or so quickly when once the fever appeared that one could not be sure the creatures had imbibed infective blood; but finally a number were secured from a dead goat that had been in fever four days.

1. Animal No. XXVII, Boer ewe goat. Received Cape Town stable March 13th. Infested March 27th with several thousand Blue Tick larvæ reared from females taken from X when dying February 12th. Animal was in wofully poor condition and was troubled with diarrhœa. It did not relish the dry forage and was kept alive on grass. After lingering on through all the critical period for heartwater it succumbed to dietetic troubles on April 20th. Many hundreds of engorged females fell from it on the last two days.
2. Animal No. XXVIII, Boer ewe goat. Received Cape Town stable March 13th. Infested March 27th with several thousand Blue Tick larvæ reared from females taken off X when dying February 12th. Like its mate, XXVII, this animal ate little and was daily expected to succumb from dietetic troubles. It appeared to suffer also from the heat of the stable and the presence of the ticks. These dropped in hundreds after the 24th day. About March 18th it began to purge, but fortunately it held out until the 24th, quite long enough to show that heartwater had not been transmitted by the ticks.
3. Animal No. XLIV, Boer kapater goat. Received Rosedale stable June 10th. Infested August 28th with Blue Tick larvæ reared from a female taken off a dead heartwater goat, May 13th. Very few appeared to attach, and only ten females became engorged. No fever appeared and the animal afterwards proved susceptible.

These tests leave little doubt that the Blue Tick is harmless as regards heartwater; but because two of the animals succumbed so soon after the critical period and the third had so few ticks, the tests are not entirely conclusive and will be repeated during 1902.

S. The Tampan does not transmit Infection.—The Tampan (*Onithodoros savignyi*, Audouin) is more nearly related to the common Fowl Tick, with which it is sometimes confused under the same name, than with any of the common species of ticks found on stock. Although best known by its attacks on travellers, the Tampan bites sheep and goats freely. It is a tick that is widely distributed in Africa but I have not heard of it in heartwater sections. Its habit is to engorge itself at once when it is applied to a host and generally it is on and off again within an hour. After a feed it rests for many weeks or months and, generally at least, sloughs its skin if immature, or lays eggs if a female, before again seeking an animal.

1. Animal XXXIX when in the height of its fever, Nov. 14th, was infested with Tampans in all stages of development; within half an hour all had become puffed out with imbibed blood. The specimens came from German South West Africa, in February, 1900, and hence were very hungry when applied. Although it was summer they did not seem inclined for food again for more than two months. Eight representing both sexes and nymphs of different moults were applied January 29th to LII, an Angora cross bred goat previously used in series M tests. All fed and the critical time has passed without there having been any indication of fever.

It is probable that all blood sucking parasites other than the Bont and perhaps its close allies are as harmless as the Tampan as far as heartwater is concerned. Dogs have been

kept in the goat sheds during the year, and fleas from them have freely gone on to the goats and doubtless have migrated from sick goats to healthy ones. On many occasions numerous flea eggs have been found in the catch cloths of the animals and flea progeny have often been unintentionally carried through their transformations in the dishes in which ticks were set aside to moult. Lice of two species have been common and have so swarmed at times that great numbers from sick animals must have wandered on to healthy goats.

SUMMARY OF RESULTS.—The Bont Tick only, so far as has yet been ascertained, is concerned in the natural transmission of heartwater. The Bont Tick, however, is normally as non-infective as other ticks and it is only when it has fed on a diseased or convalescent animal that the capacity to infect is acquired. It appears that the infection does not pass through the egg stage of the tick; but it is certain that infection acquired by larvæ may persist and be communicated by adults even when a non-susceptible host, as an ox or a salted sheep or goat, nourishes the intermediate nymphs. A single tick can give rise to the disease in its most fatal form.

LIFE CYCLE AND HABITS OF THE BONT TICK.—To advantageously apply the teachings of the experiments, a knowledge of the life cycle and habits of the Bont Tick is essential. This tick, in common with all the other sorts ordinarily found on stock in this Colony, has four distinct life stages. First it exists as an egg; the egg hatches and there appears the larva or seed tick; the larva gains an animal, feeds and drops to the ground; after a period of rest the larval skin is sloughed and there appears the nymph; the nymph locates on a host, feeds and drops off as did the replete larva; again there is a quiescent interval followed by a second casting of the skin, and the adult appears. The adult male lives to fertilize females; the female finds a host where a male is present, engorges herself, and then falls to the ground wherein or whereon to lay her numerous eggs, of which there may be fifteen thousand or more. The larva is a mere animate speck at first but swells out into a plump blue-black miniature of an engorged female. The increase in length is from about one-fortieth of an inch

to one-twelfth. The larva has only six legs and is thus easily distinguishable from the nymph. The nymph as it finds a host is a flat, brown creature about a twelfth of an inch long and by its colour, size, flatness and great activity forcibly reminds one of a third grown bed-bug. It increases to about one-fifth of an inch in length by its feeding but its growth is better told by its increase in weight which is full thirty-five times; the colour changes to bluish-grey. When fully engorged it superficially resembles the common Blue Tick, but it is shorter and proportionately broader, and darker in colour. No method of distinguishing the sexes during the larval and nymphal stages is known. The absence of a genital orifice serves for the easy separation of nymphs from adults in all ticks. The adult Bonts are too well known to require description for those who dwell in heartwater districts; it may be mentioned, however, that engorged female specimens which measure fully an inch in length and three-quarters of an inch in width and weigh one-tenth of an ounce are quite common. Probably no other species of tick clings more tenaciously to its host. Often a piece of flesh tears away when a specimen is forcibly removed and quite as often as otherwise the rostrum is injured. Recently a partly engorged female with a thin band of muscle two and an eighth inches long was received from an East London farmer who reported that the specimen had been pulled from a festered sore on one of his cows.

The life stages of the Bont Tick are of variable duration, largely dependent upon the degree of heat and hence the season of the year. Development is rapid through the summer and very slow during the winter and therefore both the tick and heartwater are most common in the warm season. The period from the time the female drops to the time she commences to lay has varied in specimens observed from twelve days in summer to twelve weeks in winter; and the complete period from the dropping of the female to the hatching of the eggs, from eleven weeks in summer to thirty-six weeks through the winter. The time from the dropping of the larva to the appearance of the nymph has varied from twenty-three days to twelve weeks; and from the dropping of the

nymph to the appearance of the adult, twenty-seven days to fourteen weeks. These records are for rearings over moist sand in an unusually warm Cape Town office. In an incubator heated to 87°-92° F., larvæ have moulted in fifteen days and nymphs in twenty; a higher temperature than 95° seemed rather to retard than to hasten development.

The period spent on the host appears to be practically the same summer and winter but differs with different animals and on different parts of the same animal; it generally takes less time, for instance, for specimens to become engorged on an ox than on a sheep or a goat, less time on some goats than on others, and less time on the udder or belly of a goat than on its legs and feet. In general the feeding period of the larva and nymph varies from four and a fourth days to eight days; occasionally on the legs and feet of a goat it is lengthened upwards to twenty-five days. The period spent by the female appears to depend very much upon the virility of the male with which she mates; if he is a worn and feeble specimen she may stay several weeks but ordinarily she stays about eight days on an ox and nine to ten on a goat. The male remains on indefinitely. Large numbers have been observed to remain upwards of fifteen weeks; a single one which attached to a cow on October 2nd, 1899, was still on in the same position on September 22nd, 1900, when the cow was sold and sent away. It had no mates.

The period through which the Bont Tick may survive whilst awaiting a host seems longer in winter than in summer. In the cool months larvæ have been kept seven months without food, nymphs six months and adults six and one-half months; only a few of large numbers, however, have remained alive for so long. In series B of the experiments is mentioned a case of fever produced by ticks that moulted in July and were applied in January of the following year. The larvæ mount grass or bushes and await the passing of animals. Nymphs and adults hide in the ground, sometimes out of sight in loose dirt or in holes; the presence of animals near by attracts their attention in some undetermined manner and causes them to run actively about in search of the desired prey.

At least one year is probably required for a complete life cycle even when little time is lost in finding a host, and it is quite likely that two years is often occupied, whilst even so lengthy a cycle as two years and a half is not impossible. The warmer the locality and the more abundant the stock, the shorter becomes the period.

Some kinds of ticks (as the common Dog Tick, *Hæmaphysalis leachi*) desert their host on its death but it seems unusual for the Bont Tick to exercise this means of possibly saving its life; it generally remains on the skin and there perishes. An odd male occasionally wanders off and, naturally, all such individuals which as larvæ, nymphs or adults have practically finished feeding or only just begun also loosen their hold and crawl away.

Deductions from the Knowledge gained.—As the transmission of heartwater apparently depends upon a tick, it appears quite certain that its prevalence depends upon the abundance of the species of ticks that can communicate it. That the Blue Tick, the Red Tick, and the Tampan all seem wholly incapable of carrying the infection is strongly indicative that kinds of parasites other than ticks are not implicated and that if any species other than the Bont Tick is concerned it is a close ally. The closest relative to the Bont in the Colony is the Schildpad Tick (*Amblyomma devium* Koch), a species found on snakes and tortoises. Nymphs have been found on goats but only a few. The next nearest relative is the Bont Leg or Bontepooten Tick (*Hyalomma ægyptium*, Audouin). This is a widespread species that occurs in great numbers in the Willowmore, Aberdeen and other Midland districts. Fourteen attempts to rear its larvæ on goats were made during the past year without a single success, and attempts to infest a cow, a cat, a guinea pig, a dog, a fowl, a tortoise and my own person were also failures. Until we learn how to rear the species, we cannot determine its behaviour towards heartwater. The normal larval host may not be any kind of stock.

But whether or not other kinds of ticks can transmit the disease, the fact remains that the one kind, the Bont, is the principal agent. To suppress this tick on a farm is, I believe, to check the disease; and to prevent its introduction to a farm is to keep the disease away.

Farmers in heartwater areas should bestir themselves to learn what measures are of most value in destroying the tick; and farmers just outside of the area should learn to know the tick and see to it that it does not get established on their veld. Horses and cattle that have returned from Bont Tick areas should be examined and every Bont pulled off. Stock purchased at fairs should also be well examined. It is difficult to find larvæ and nymphs but the adults are conspicuous. It is dangerous to allow males to remain for males attract females, and whereas clean horses or cattle away four or five days on Bont Tick veld would probably return without a single female, they would bring numerous specimens were a few males present on them at the start. The abundance of the tick on a neighbouring farm should not discourage a farmer from doing his utmost to keep his stock clean; it sometimes happens that a wire fence separates a practically clean farm from a badly infested one.

Goats and sheep serve as efficient hosts for the Bont Tick but my impression is that the multiplication of the pest is almost wholly due to cattle. It is hard to get a stand of nymphs or larvæ on sheep and nearly all that do bite attach to the legs and feet. Goats are far more freely infested by the early stages. The adults mainly attach to the legs and feet of both sheep and goats although the bare places back of the shoulders and between the thighs are also favourite places. The adults bite deeply and irritate small stock exceedingly; in consequence the animals bite and scratch the affected parts, thus preventing many of the females from maturing. It was only by keeping the infested legs in stockings that engorged females were secured in the experiments; almost all adults that were not protected were soon rubbed or bitten off. Cattle seem much less sensitive to the ticks and are, besides, less able to free themselves of them. The farmer should remember these facts and avoid, as much as possible, from running small stock on veld where Bont Tick infested cattle are or have been.

The prompt removal and isolation of heartwater animals will serve to minimize the number of cases. To get the best results the flocks and herds should be watched [illegible]v and the animals that look the least ill should be

removed from the others at once and kept where ticks that drop from them will have little or no chance of subsequently getting on animals susceptible to the disease. One or more small quarantine paddocks might with advantage be arranged near the homestead. Animals that recover should not be allowed to mingle with susceptible ones or even to cross the veld used by the latter until they have been well at least a month.

Some farmers bring sick animals into sheds where they keep rams. There is danger to the rams in this practice for larvæ or nymphs might drop off in the sheds and after moulting wander to the ram pens. As a matter of fact the danger is little because there are usually large numbers of fowls about the sheds and yards on the look-out for dainty morsels like engorged ticks. If quarantine paddocks for sick animals are used, fowls should be encouraged to run there; in fact fowls and tick-eating birds should be encouraged to frequent the kraals and other places where the animals rest.

The experiments show that there is danger of bringing the disease into new veld with stock of all kinds from heartwater areas. This danger lessens with the increase in time between leaving the heartwater area and depasturing the animals on the new veld and is very slight after a week, the ticks capable of carrying the infection having by that time nearly all dropped off. Engorged ticks in all stages of growth are easily injured and most of those that drop from a herd or a flock when passing along a road are undoubtedly destroyed by being trampled upon. At resting places, the ticks are much more likely to escape.

In the light of the experiments, it is quite reasonable to suppose that heartwater infection can be eliminated from any tract of veld by simply excluding all susceptible animals for a period. To simply eliminate the disease would not be a very great advantage for as long as the Bont Tick remained in numbers the disease might at any time be re-introduced by a single sick or convalescent animal or by one or more pathogenic specimens of the tick brought perhaps by an ox or a horse, and when introduced would spread with awful rapidity. But it is conceivable that by excluding all animals for a period, both the tick and the disease might be eliminated; and that, then,

ordinary care would suffice to prevent either the tick or the disease from becoming again established. In the United States the redwater area is being slowly but surely diminished in extent by the eradication of the tick that transmits the disease. The Chief of the Bureau of Animal Industry in the 1899 report of the Bureau says on this subject:—

> "Another line in which progress has been made is in lessening the area of the infected district. Whole counties have been placed above the cattle quarantine line, because the ticks have been destroyed in those counties and the danger of contagion removed. In many other counties the citizens have taken up the task of tick killing and are making rapid progress in freeing their districts from this pest."

The means used in exterminating the tick, in this case a close ally to our Blue Tick, are not stated in the report but from other writings it is quite certain that reliance is placed almost wholly upon the starving out plan.

Field experiments on an extensive scale to determine (one might almost say examples to demonstrate) the feasability of banishing heartwater and the Bont Tick from any given area are much needed, and the farmers of south-eastern districts are urged to give the matter serious attention. The Government might, justifiably, be asked to conduct the work and bear the expense; but with no session of Parliament in prospect through which funds might be secured, and for other good reasons, it is suggested that farmers might well emulate the example of the American stockmen who are ridding their districts of redwater and its transmitting tick. The farmers' associations in some of the worst heartwater sections, say those in Albany, Alexandria, and the lower parts of Fort Beaufort and Uitenhage districts, might with advantage, I think, form small syndicates amongst their members for purchasing or leasing sites and for defraying the other necessary expenses. The sites selected should be on notoriously bad heartwater veld. They should be securely fenced and efficient means used to prevent any kind of stock or game from getting into them. Each large enclosure might be subdivided into paddocks, and these experimentally stocked in succession with susceptible animals at the expiration of twelve, eighteen, and twenty-four months; if the expense of subdividing were not too great, other paddocks might be left for fifteen and thirty months.

It is recognized that birds and small animals would remain on veld that might be closed and that no control could be exercised over these creatures; also that some bucks and perhaps even larger game might have to remain. For experiments, it would be advisable to use enclosures containing no large wild animals; but in the practical application of the idea to farms in general, I do not think that game will have to be reckoned with as a factor of importance. As far as I have learned the Bont Tick is rarely seen on bucks of any kind even in badly infested areas except on old, emaciated animals, and I have not heard of its being taken from hares. The common tick that infests tortoises is a distinct species. Some farmers think that locusts often carry the young ticks from one farm to another, and while one can imagine that a few ticks may at times be transported for some distance by winged locusts incidental to their migrations, the chances, it seems to me, are very much against clean veld becoming infested in such a manner.

The Treatment of Buildings with Hydrocyanic Acid Gas for the Destruction of Vermin.

Hydrocyanic acid gas fumigation, during the last fifteen years, has become a well established and widely practised remedy for the scale pests of citrous trees; and with the growing recognition of its efficacy and safety for this purpose its use for the destruction of insect pests within buildings has gradually developed and is rapidly becoming more and more common. Familiarity breeds contempt and the man who safely fumigates a tree and witnesses the truly remarkable results in scale riddance is not likely to hesitate in adopting the treatment to a vermin infested bedroom of his dwelling regardless of the fact that he is dealing with one of the most violently poisonous of chemicals. As time goes on the gas will probably become even more widely employed as an insecticide for pests within doors than for pests without, particularly in warm countries like the Cape. The fumigation of trees has been constantly recommended by the writer but the application of the remedy to indoor pests has been discouraged rather than encouraged for the reason that the risk of poisoning oneself or others is far greater indoors than out and that an accident might prove seriously detrimental to the development of the practically indispensable and comparatively safe outdoor employment of the gas. But since indoor fumigation has come to stay it seems advisable to publish explicit instructions for the guidance of indoor fumigators as a precaution against accidents which might arise from ignorance of the risks involved and from ill-considered procedure in the operations. The number of enquiries at the office for particulars, almost all of them made confidentially and in person, also render it expedient to have full directions in print since an essential detail may be misunderstood or perchance left unmentioned in conversation.

The writer's experience in indoor fumigation with hydrocyanic acid gas has been fairly extensive although almost wholly quietly acquired by occasionally assisting acquaintances. Beginning with the successful treatment of a suite of college rooms for a plague of fleas nine years ago, he has directed the fumigation of an aggregate of several

hundred rooms, some in private houses, others in boarding houses, school dormitories, club houses, hotels, public buildings and gaols, some for bed-bugs and others for fleas or roaches, and has thus gradually gained a sufficiently varied experience to be able to treat of the subject from practical as well as theoretical knowledge. Again, conversation with confiding complaintants, some idea of conditions of various gaols, barracks and asylums in the country and several unpleasant hotel experiences, have convinced him that the vermin problem is really very serious in South Africa and that the employment of the remedy under discussion is often quite justifiable.

APPLICABILITY OF THE TREATMENT.—The remedy is applicable to all spaces that can be made approximately air-tight and the ventilation of which can be effected from without, and from which it is practicable to exclude everybody and all moist food-stuffs and water during the period of treatment. Perfectly dry food-stuffs as sugar, flour, oatmeal, and the like are not injured but any edibles, including fruits, that are exposed should be thoroughly aired for several hours before being used as food. Probably insects of all kinds as well as all higher forms of animal life are susceptible to fatal poisoning from hydrocyanic acid gas in the presence of sufficient air to otherwise sustain life. Some creatures, however, are able to withstand the gas at greater strength and far longer than others. Flies are much more susceptible than fleas, and fleas than bed-bugs, whilst the common tick of the fowl (*Argas persicus*) is so extremely resistant that it appears quite unaffected by gas that is twice as strong as is required to kill bed-bugs in a given time. The eggs of the bed-bug, of the flea (at least the dog flea, *Pulex serraticeps*), and of the small roach (*Ectobia germanica*) are devitalized almost if not quite as readily as the parent insects. Clothes moths, silver-fish, house centipedes, and the numerous insects that commonly feed in dried fruits, meal and grain have been found to succumb along with the more loathsome house pests. The remedy is not applicable, however, to insects bedded deep in masses of their foodstuff like weevils in stored grain. Rats and mice are readily killed but owing to their often having means of egress from the space the gas is not specially adapted

for their suppression though under some circumstances very satisfactory results may be obtained. House plants are liable to severe injury by gas at the strength necessary for vermin.

House fumigation may be conducted at any season of the year and in daylight as well as darkness, but a greater degree of success is likely to be obtained in summer than in winter and on quiet days than when there is a high wind.

PREPARATION OF THE SPACES.—The spaces to be fumigated should be made approximately air-tight. Ordinarily each room or space should be treated separately but it is often convenient and even preferable to treat two or more connecting spaces as a unit. Apertures of all descriptions leading to the outer air should be stopped as well as circumstances allow. The stopping when possible should be done from without and in such manner as not to shelter any vermin. Particular attention should be paid to apertures near the roof or ceiling. If corrugated iron confines the space on any side it may be necessary to plug all the laps and the open spaces formed by the corrugations as at the sills of the roof and along the peak. Heavy paper pasted or tacked in place serves well to close air spaces through the wall and broken windows. Crevices within the space, such as ceiling cracks, wall cracks, splits in door casings, and the like, should be left fully exposed and in some cases may with advantage be made larger so as to admit of more ready access by the gas. The windows and outer doors should be secured in such a way that they can be opened from the outside; unless they fit very loosely, the crevices between them and their casings may be ignored.

Bedding, clothing and other effects left in the space should be so disposed as not to shelter crevices in the bedsteads or walls and as far as possible their entire surfaces should be exposed. It is a good plan to bring in extra chairs over which the articles may be spread, and advantage should be taken of hooks and nails from which things may be loosely suspended around the walls.

All articles of food that are not to be fumigated should be removed. No water or other liquid not in tight receptacles should remain. Liquids absorb the gas and hence to prevent loss through such absorption it is necessary to draw off the water in tanks even if it is not to be used for

drinking purposes or for cooking. Meat and water exposed to strong gas have been given to dogs soon after removal from treated spaces and the fact thus demonstrated that such articles may absorb enough gas to become fatally poisonous. Meat, eggs, butter, lard and such commodities should, therefore, not to left. No injury is done by the gas to the ordinary furnishings of dwellings, even the most delicate colours in cloth fabrics and paintings remaining quite unaffected.

CHEMICALS.—Cyanide of potassium in lump form and of the purest commercial grade (98-100 %) only should be used. Whilst the lumps should be white and crystalline, dark discolorations and honeycombed surfaces do not necessarily imply inferiority of consequence. As a rule, the lumps need to be broken. For single charges of a pound or more the pieces may be as large as an egg but for charges of a quarter pound or less they had best be not much larger than common acorns or lump sugar. In breaking care is needed to prevent the lumps being powdered, and to this purpose quick sharp taps rather than heavy blows should be struck. Powdered cyanide can be used but should be worked off as made with lumps; it gives a full but a quick and violent reaction. To prevent splinters of cyanide being scattered about it is well to hold the lumps within a fold of cloth when breaking them.

Cyanide deteriorates when left exposed to air and hence should be stored in tight tins or jars. When handling large quantities, particularly on damp days, it is wise to wear rubber gloves, but ordinarily it may be handled with cloth or leather gloves or with the naked hands; if the hands are not protected they should be thoroughly washed and wiped perfectly dry at frequent intervals to prevent the skin from becoming harsh, dry and sore about the nails as from handling lye. The quantities may be weighed out on ordinary balance scales with the pans protected from corrosion by a layer of paper. If not to be used at once the different lots should be placed in thin paper or cloth bags and these put in a tight box or jar in a dry place; the writer generally uses squares of mosquito netting or muslin gauze with the four corners gathered together and tied. Labels to distinguish charges for different spaces may be necessary.

The gas for the fumigation is generated by acting on the charge of cyanide with a proportionate quantity of dilute sulphuric acid, the two chemicals being brought together in a receptacle which for convenience is termed a "generating vessel."

Commercial sulphuric acid of full strength is intended in these directions and if acid of less than 90 % purity is used due allowance should be made for the comparative weakness. Practically all the acid sold in the Cape Colony is, however, of the proper grade. The most convenient form for the work in which it comes packed is in cases of four 42 lb. jars. Whilst the net weight of acid is only 168 lbs. the gross weight may exceed 400 lbs., and on account of the heaviness of the cases, great care is needed in off-loading them in order not to break the jars. Purchases may be made by the case, jar or pound. A wine bottle holds about three pounds. Whilst generally clear and colourless as purchased, the acid may be black and quite opaque yet practically of full strength. Discoloration is due to the charring of foreign substances, such as a wisp of straw or particles of wood or paper, and the facility with which these substances are attacked and destroyed cautions one to be careful not to spill or splash it. A few drops in the eye might cause permanent loss of sight.

Water is used to dilute the acid for use. Invariably the acid should be poured into the water; never, the water into the acid as thereby splattering may be caused. No stirring is necessary. Heat arises from the mixture and is necessary for the reaction with cyanide which is to follow. Boiling water or even hot water should not be used as the addition of the acid is then likely to raise the temperature to so great a degree that the mixture boils over.

One part by weight (avoirdupois) of cyanide to one part by fluid measure of acid in two parts by fluid measure of water is the correct proportion of the chemicals for use in forming the gas. This is equivalent to 20 oz. of cyanide in a mixture of one quart (Imperial measure) of water and one pint of acid. More acid may be used but is unnecessary. Additional water even to the extent of an extra part does no harm as a rule but all surplus water detracts from the heat of the mixture and may thus impede the reaction with cyanide.

GENERATING VESSELS.—It is essential to use vessels not easily destroyed by the action of the chemicals. No special form is requisite, although in general one with a rounded bottom inside is preferable to a flat-bottomed one. The size required depends upon the size of the charge of chemicals; as a rule a vessel to take a one pound charge of cyanide should be of at least six quarts' capacity. Glazed earthenware jars with wide mouths, china wash basins, china pudding basins and such like receptacles when perfectly sound answer well as generating vessels. China wash basins are perhaps most widely used in dwelling house work; if they are in the least cracked they are apt to break and any surface cracks they have may become much accentuated, and occasionally they get stained blue from impurities in the cyanide. Lead vessels last very long but are heavy to handle and are easily knocked out of shape. Enamelware, when of the best quality and perfectly sound, does well until chipped; then it is soon eaten through. Galvanized iron utensils are attacked at once by the acid, but if well jointed they may last through a few operations. Wooden buckets answer better than might be expected, but the hoops need close watching. Tinware is only slowly attacked and may sometimes be used to advantage; it must not be rusted. Paraffin tins, being very cheap and obtainable everywhere in the country, are exceedingly useful for the purpose, but are not trustworthy for more than two or three operations. One easily takes a charge of three pounds of cyanide; when a charge of a pound or less is used the tin should be tilted on edge in order that the lumps may be covered by the acid-water mixture. Wash basins of ordinary size are not safe for charges of over two pounds, and it is better to consider one and one-half pounds their limit. The vessels are not made poisonous by their contact with the chemicals, and after they have been thoroughly cleansed in an abundance of water they may be safely returned to the kitchen or bedroom as the case may be; this remark, however, does not apply to unglazed earthenware.

CHARGES FOR GIVEN SPACE.—The charges of chemicals for given spaces are for convenience herein discussed in terms of cyanide; the use of acid and water in the proportions already cited must be understood. The charge

of cyanide necessary to destroy bed-bugs within a two hours' exposure is believed to be about one ounce to one hundred and fifty cubic feet; from experience, however, it appears to be inadvisable to use a charge of less than an ounce to one hundred cubic feet, the expediency of the heavier charge arising from the wholly indefinite protection which many of the insects receive by their surroundings. An exposure of at least two hours in length should be given and as much longer as can be arranged for, even up to twelve or twenty-four hours. Where the circumstances appear unfavourable for the retention of the gas and where deep cracks or crevices must be penetrated, as where the spaces are roofed with reeds for instance, a greater quantity of cyanide, say an ounce to about sixty cubic feet, that is one pound to about one thousand cubic feet, had better be allowed; and special conditions may warrant even a still heavier charge. No allowance need be made for the furnishings or other contents of a room; thus a furnished room thirty feet long by fifteen wide by ten high should be reckoned as requiring a charge for 4,500 cubic feet, and at the standard rate of an ounce to one hundred cubic feet would be given forty-five ounces or two and three-quarter pounds.

It does not seem advisable to attempt, ordinarily, the use of more than three pounds of cyanide in a single generating vessel. Two or more vessels may be used and the charge divided amongst them when a space requiring more than three pounds is treated.

There is no danger of an actual explosion with hydrocyanic acid gas but as the concentrated gas may be ignited one should take care not to bring flame near a generating vessel when gas is coming off; and as currents of gas strong enough to ignite may circulate for a few minutes, burning lamps, gas-jets, open fires and the like should not be left within spaces during the exposure.

Procedure of Operations.—Having prepared the spaces, calculated and then weighed out the charges of cyanide, and got the requisite generating vessels in readiness, one is ready for the operations more immediately incidental to the generation of the gas. The generating vessel should be placed in an open space, say near the middle of the room, or if several vessels are used in a row down

the middle with as much distance as possible between them. There is always a chance that a chip of cyanide or a drop or two of acid may fall, so the floor beneath and round about the vessels should be protected, say with a few thicknesses of newspaper. The charge of cyanide in its bag of paper or thin cloth should be laid down within arm's length of the vessel. The water may be measured directly into the vessel, and also the acid if there are to be a few discharges only; if there are to be many discharges and consequently a lapse of some minutes between beginning to measure off the acid and starting the reactions, it is better to measure the acid into an earthen jug, cup, sound jam-tin, or such-like receptacle, and to place this close at hand, and then, when all the acid is measured, to mix one lot after another with its complement of water. In this way a hot and active acid-water mixture is assured.

Everything finally being in readiness for the generation of the violently poisonous gas, the operator, beginning with the vessel farthest from his exit, drops the bags of cyanide into the steaming acid-water mixtures in quick succession, keeping at arm's length and averting his face in doing so and holding his arm low to lessen the chance of a splash. As far as possible he should refrain from breathing in a room when once he has started a reaction, for a very little of the gas might overcome him and a single breath of pure gas would probably prove quickly fatal. However, highly poisonous to man as the gas certainly is, it is not known that anybody anywhere has yet suffered in the discharge of the chemicals for such purposes as are being considered, and it therefore seems as if the careful exercise of obvious precautions is sufficient to guard against accident.

Ordinarily, however much help the operator may have, he should himself attend to the dropping of the cyanide and have everyone cleared from the space before he begins. But when a number of rooms along both sides of a passage are to be done, and particularly if the doors are to be left open, it may be advisable or even necessary to have an assistant attend to those on one side while he attends to those on the other; the charges in opposite rooms may then be dropped simultaneously. When a large number of rooms

are being done, an assistant may sometimes also be an advantage by attending to the addition of the acid a few rooms in advance of the operator whilst the latter follows and drops the charges and shuts and locks the doors. If two or more floors of a building are to be done, the uppermost should be started first. Should any mistake occur in the final operations, such for instance as the overlooking of a room or any vessel in a room, the operator should think twice before venturing to rectify the matter; on second thought it may be deemed better to abandon the operations and to begin anew on another day than to risk the correction.

When a single reaction only has to be started, far less forethought is necessary then when multiple discharges are in order. The water and acid may be measured into the vessel direct, the cyanide dropped, and a leisurely exit be made. The cyanide may be dropped in loose as it is in orchard fumigation yet it is preferable when a pound or more is used to have it in a wrapper even if this be only a square of newspaper with the corners turned up.

The procedure outlined is that used at the Cape and is simply a modification of the orchard practice. A number of American writers recommend a somewhat different plan. They advise that the bags of cyanide be suspended by strings above the generating vessels and the strings be extended through eyelets to without the spaces. A large room might have a dozen vessels each with its charge hanging above it. Then after all is in readiness the operator locks the doors and lowers the charges. Because of its comparative simplicity and the absence of all risk of an accidental discharge, the present writer considers the Cape method the safer.

As soon as he has started the reactions, the operator should lock the doors leading into the spaces and take charge of the keys. The escape of gas about the outer doors sometimes needs to be guarded against but generally a mat or a wad of paper across the bottom of each is all that is required. It is well to loosely plug the keyholes as a precaution against any party, unaware of the operations, striving to enter by the aid of other keys. In hotels and all other buildings to which many persons have entrance, prudence dictates that a watchman be stationed to prevent anyone by mischance going into the closed spaces.

The period of exposure as already mentioned should be two hours or longer. No harm would result so far as the gas is concerned were the spaces to be left closed a week but twelve hours or over-night is as long as is usually convenient and by the expiration of that time the gas has generally nearly all escaped.

VENTILATION.—After the expiration of the period of exposure, as many of the doors and windows as possible should be opened from without and the spaces allowed to air for a half-hour or longer before anyone enters. The time necessary for thorough ventilation depends greatly upon the size of the rooms, the period of exposure, the size and position of the doors, windows and ventilators that may be opened and the occurrence of wind; hence no time limit can be laid down. A leaky space exposed for twelve hours during a strong wind may need no airing at all to make it perfectly safe to enter the moment the door is opened and to at once sleep in it; but in general not less than three hours should elapse before a space is again closed and occupied and unless the draught is good four or five hours had better be allowed.

The ventilation of the spaces is really the most responsible part of the operations for it is then, more than at any other stage, that there is risk of an accident. Oft-times the windows cannot be opened from the outside and the operator must, after very imperfect ventilation through door-ways for say half-an-hour, enter and throw open the windows to get draught. If he is a careful man he holds his breath until he can get fresh air through the open sash. But it is not to the operator that there is most danger; rather is it to the obliging party who always wants to help but whose inexperience renders him useless, and to the inquisitive party who cannot control his curiosity to have a peek around to observe the effects of the work. Then, too, the spaces being open, unsuspecting parties are more apt to intrude. The dilute gas is invisible and its slight odour, like almond flavouring extract, is hardly noticeable after the first few sniffs; yet nausea, a splitting headache for many hours afterwards, and even more unpleasant results are mild penalties for venturing too early into spaces that have been fumigated.

THE REFUSE.—The refuse left in the generating vessels should be buried or washed down a drain where it can do no harm. Whilst very little cyanide in any form remains in it, there is some free acid; the bulk of it is sulphate of potash, a substance of considerable manurial value. For an hour or more after the reaction, according to the quantity there is of it, the mass is liquid; later it assumes a stiff, pudding-like consistency, and still later its solid ingredients crystallize and its water is gradually lost by evaporation. Colour may be altogether lacking or it may shade from white to blue.

Lumps of cyanide in the refuse show that the reaction was incomplete. If much of the chemical has remained undissolved, a repetition of the fumigation may be necessary. Incomplete reactions are usually due to the acid-water mixture being cool at the time the cyanide is added, in other words, to mixing the acid with the water too soon; but they may be due to the use of too large lumps of cyanide or to the use of so broad-bottomed a generating vessel that there is insufficient depth to the acid-water mixture. The surfaces of the lumps of cyanide remaining in the refuse are usually charred black.

FUMIGATION A SUPPLEMENTARY MEASURE.—The fumigation of indoor spaces should be considered at the most as only one of a series of measures for the control of insect nuisances. Thorough house cleaning methods should immediately follow fumigation; and perhaps amongst the victims of the gas may be swept up some undesirables which if left undisturbed might ultimately recover. The walls should be repaired wherever broken and often re-papering is very desirable. Without cracks and crevices in the walls and ceilings in which to hide during the day and during their long rests after feeding, bed-bugs are practically confined to the bedsteads and it is a bad housekeeper indeed who cannot conquer them there without the aid of hydrocyanic acid gas. Nail holes and other breaks in the walls should never be overlooked in a search for the creatures and one should always be on the lookout for the dark flecks of excrement that may betray their hiding places. Similarly, it is undisturbed corners and neglected places beneath and back of the cooking stoves and heaters and around the sinks that account for the abundance of

roaches in colonial hotels and club houses. An abundance of any of the common house pests is an almost certain indication of slackness in details of cleanliness, and when the shortcomings are recognized their continuance is seldom excusable. If fumigation with the gas is used and is successful in setting matters aright, good housekeeping should suffice to almost indefinitely prevent a recurrence of the trouble.

Altogether, the hydrocyanic gas measure should be considered a final resort as when ordinary measures fail or the problem has assumed a wholesale nature. The gas for house vermin destruction should be regarded in much the same light as dynamite for the removal of tree stumps, a cheap and simple but heroic treatment justified and made expedient by circumstances; and as in the employment of dynamite only responsible parties who are cognizant of the nature of the chemicals and of the risks involved should attempt fumigation. An hotel or boarding-house keeper or a landlord with vacant hire houses, for instance, may be quite justified in having the gas used, but he should never entrust the operations to uneducated or careless employees; if possible he should engage one or more men perfectly familiar with the operations to undertake the work and if such operators are not procurable he should not feel it *infra dignitatem* to qualify himself and to then supervise the work and personally handle the chemicals.

As a wholesale remedy for the destruction of vermin in hotels, club houses, barracks, prisons, asylums and other institutions in which large numbers of people are housed, and for various injurious insects and other creatures in empty warehouses, mills, granaries and even ships, the gas has a wide field of usefulness, but a field in which expert fumigators only should ordinarily venture.

RECAPITULATION.—To summarize, hydrocyanic acid gas is applicable for the destruction of almost all insect pests in closed buildings. All life, animal and plant, which it is not intended to destroy, as well as all water, meat and moist foodstuffs, particularly that which may be consumed in an uncooked state, should be excluded, and the spaces should be made approximately air-tight. The ingredients needed for the formation of the gas are 98%-100% cyanide of potassium in lumps, concentrated commercial

sulphuric acid, and water; and these may be mixed in any receptacle not readily attacked by the acid that will give a sufficient depth of the liquids to cover the lumps. In general the vessel should have a capacity of about six quarts for each pound of cyanide used in it, and a charge of three pounds of cyanide is as large as it is convenient to use in one vessel. Many vessels may be used in a single space if necessary and several spaces may be treated together. One ounce or more by avoirdupois weight of cyanide should be allowed for each one hundred cubic feet of enclosed space; and for each ounce of cyanide, two fluid ounces of water and one fluid ounce of acid should be employed. Some protection to the floor as by papers spread beneath and around the generating vessels is advisable. The water is first poured into the vessel, and then the acid, and while the water-acid mixture is hot, as it becomes by chemical reaction, the cyanide is added. The cyanide should be in lumps not larger than eggs for large charges nor than acorns for small charges, and for convenience in handling and dropping had best be enclosed in bags of paper or thin cloth. A violent chemical reaction with evolution of white clouds of steam and gas takes place as soon as the cyanide comes in contact with the hot acid, and breathing within the room soon becomes unsafe. The operator quits the spaces immediately and leaves them closed for two hours or more, even as long as a day and night if a long exposure can be conveniently arranged. The gas diffuses through the enclosed spaces and gradually escapes into the outer air, meanwhile effecting the destruction in life for which it was generated, and perhaps it may have all disappeared when the room is again opened if the exposure were of long duration; ordinarily much remains and breathing within the room may be positively dangerous until ventilation through open doors and windows has proceeded a half-hour or more. As a rule the windows and doors that may be moved should be opened from without and at least half-an-hour allowed to elapse before anyone enters even to open the remaining windows and doors. Spaces may generally be occupied with safety after they have been ventilated three or four hours. The refuse should be buried or thrown down a drain, and after thorough washing the vessels may be returned for their ordinary uses.

Fumigation in the case of inhabited buildings should be regarded as an heroic measure that one can command to supplement milder treatments when the latter fail. The gas may be compared to dynamite, both being substances whose usage is simple and exceedingly effective for certain purposes, and which though safe in careful hands familiar to them are fraught with danger to careless or ignorant novices. It is believed that the directions for fumigation with the gas herein set forth are sufficient for the guidance of intelligent parties, but as intimated in the opening paragraph the writer is not endeavouring to encourage indoor use of the remedy by the general public.

EXPERIMENTS WITH INSECTICIDES.

(By C. W. Mally, M.S., Assistant Entomologist.)

The question of convenient and efficacious insecticides is an important one for every agricultural community and well deserves the careful investigation necessary to determine what remedies can be most successfully employed in any section to supplement proper cultural methods and the work of beneficial insects such as ladybirds and internal parasites. A number of experiments, supplementary to the work of previous years, were this year conducted in regard to remedies for the White Peach Scale (*Diaspis pentagona* Targ.), the Red Scale (*Aspidiotus aurantii* Maskell), and the Woolly Aphis or American Blight (*Schizoneura lanigera* Hausm.). Although their natural enemies are an important check on them, these pests still become sufficiently abundant to do very serious injury, and this necessitates the employment of artificial means to keep them in subjection. A general summary of the investigations follows.

Lime-Sulphur-Salt Wash.

Historical.—Lime-sulphur-salt wash has been used in California for many years for the destruction of scale insects on deciduous trees. East of the Rocky Mountains, however, it has not given such satisfactory results, owing, it is claimed, to climatic conditions. For the last eight years or more it has been largely used in this Colony for the destruction of the White Peach Scale (*Diaspis pentagona* Targ.). The Government Entomologist, Mr. Charles P. Lounsbury, observed that, although the trees were thoroughly sprayed, much live scale could be found for some time afterwards and still at the close of the season the trees would be almost clean. The question arose whether or not the wash destroyed the old scales or prevented the settling of the young. In either case it was important to discover the secret of the effectiveness of the wash so as to determine whether or not it could be simplified by eliminating superfluous ingredients, if any, or portions thereof. The usual wash was therefore tested in comparison with certain variations in composition and preparation, and with lime-salt, and lime when used alone.

CONDITION OF THE TREES.—Four large, moderately infested, peach trees in consecutive rows were selected for each of the 17 tests and six similar trees reserved for controls, making a total of 74 trees under observation. The buds were carefully examined and many of them were brown in the centre, indicating an injury often observed in this climate and attributed to "cold and unseasonable weather."

CONDITION OF THE INSECTS.—Live scale and eggs were present on all the trees, but in some cases at least 50 per cent. of the scales, other than those that had reproduced and died, were already dead, especially on the trunk and larger limbs,—an unexplained fact often observed during the winter season in regard to both the Red Scale (*Aspidiotus aurantii* Maskell) and the species under consideration.

PREPARATION OF THE WASH.—The wash was prepared according to the following formula :—

Unslaked lime	...	...	40 pounds,
Sulphur	...	...	20 pounds,
Salt	...	...	15 pounds.

With water to make 50 imperial gallons.

Ten pounds of lime and 20 pounds of sulphur were placed in the cooking kettle with 15 gallons of water and boiled till all of the sulphur was dissolved. This was used as a stock solution to form the basis of the following tests with varying amounts of lime and salt. The final dilution in each test was in the proportion to make 50 imperial gallons. The wash in each test was hot and kept well stirred during the application. Experiments 1 to 6 were made on the Government Wine Farm, Constantia, August 13th to 17th, and experiments 7 to 17 on the farm of Mr. Henry Meyers, Simondium, near Paarl, August 27th to 29th, 1901. The fruit buds start about the first of September, depending on the season, and hence the spraying serves for both the scale and the leaf-curl.

EXPERIMENTS.

1. Lime 40 : sulphur 20 : salt 15. The remaining 30 pounds of lime were slaked, mixed with the salt and, while hot, added to the stock solution, boiled for 30 minutes, diluted to the proper amount and applied. In the tank the solution registered 155 degrees F. Six

to eight inches from the nozzle the spray registered 140 degrees F.: about two feet away, only warm: farther away, cold.

2. Lime 20: sulphur 20: salt 15. In this test only 10 pounds of lime remained to be added to the stock solution. Otherwise same as 1. No record of temperatures was made.
3. Lime-sulphur sheep-dip,—1 part dip to 5 parts water. The strength of the wash in terms of the dissolved lime and sulphur was estimated to approximate that of the ordinary lime-sulphur-salt wash. Hot water was used in the dilution.
4. Lime-sulphur sheep-dip,—1 part dip to 10 parts water. Same as 3, except as to dilution.
5. Lime 40: salt 15. The salt and the slaked lime were thoroughly mixed and then diluted with hot water.
6. Lime 40. The lime was slaked and then diluted with hot water.
7. Lime 40: sulphur 20: salt 15. The stock solution was prepared precisely as in experiments 1 and 2 and then equally divided for the tests as follows:—
   (*A*) Boiled for 30 minutes after adding the remaining 30 pounds of lime.
   (*B*) *Not* boiled after adding the remaining 30 pounds of lime, to show whether or not the additional boiling enhances the effectiveness of the wash.

   Four trees were sprayed in each test. Trees 1, 2, and 3 in each test were thoroughly drenched with water one, two, and three days after spraying, respectively, while the fourth was left to ordinary weather conditions, to show whether or not a heavy rain a few days after spraying would seriously influence the effectiveness of the wash.
8. Lime 25: sulphur 20: salt 15. The same conditions as in 7, except that only five-eighths the amount of lime was used.
9. Lime 20: sulphur 20: salt 15. The same as 7, except that only half the amount of lime was used.
10. Lime 15: sulphur 20: salt 15. The same as 7, except that only three-eighths the amount of lime was used.

11. Lime 40: sulphur 20. The stock solution was prepared the same as before, the remaining 30 pounds of lime added,—omitting the salt,—and then boiled. To show whether the salt increases the effectivenes of the wash.
12. Lime 20: sulphur 20. The same as 11, except that only half the amount of lime was used.
13. Lime-sulphur sheep-dip. One-half gallon of dip was added to $2\frac{1}{2}$ gallons of water and then 1 pound of freshly slaked lime and 10 ounces of salt added.
14. Lime-sulphur sheep-dip. The same as 13, but only half as much dip was used.
15. Lime-sulphur sheep-dip. The same as 13, but only one-fourth as much dip was used.
16. Lime 4: salt $1\frac{1}{2}$. The lime was slaked, the salt added and diluted to six gallons. To compare with 5.
17. Lime 4. The lime was slaked and then diluted to six gallons. To compare with 6.

CHEMICAL ANALYSES.—No analysis was made of the washes used at Constantia, but the lime-sulphur solution prepared at Simondium in precisely the same way and with the same quality of lime proved to contain lime and sulphur in solution in the ratio of 1 : 1·81 (by volume). Another batch made with poorer, long slaked lime contained a higher proportion of sulphur, namely, 1 : 207. It was noticed that without exception the proportion of sulphur was decreased by the addition of the extra lime and that the half hour's hard boiling did not restore the apparent loss, the ratio generally becoming about 1 : 1·60.

The sheep-dip is a concentrated solution of combined lime and sulphur prepared for this Department for the dipping of sheep in accordance with the provisions of the Sheep Scab Act. The analysis of 10 drums, including the two used in the experiments, showed the strength to be nearly uniform and the ratio of lime to sulphur to be about 1 : 2. The addition of lime and salt in experiments 13 to 15 seemed to reduce the proportion of sulphur the same as in the regular wash.

THE METEOROLOGICAL RECORD at Constantia shows a total rainfall of 10·145 inches from August 13th, 1901, to January 3rd, 1902, distributed in 45 rains, not counting

four "trace" records, as follows:—August 13th, 0·005: 21st, 0·02: 22nd, 0·04: 23rd, 0·07: 24th, trace: 25th, 0·22: September 1st, 0·04: 2nd, 0·04: 3rd, 0·12: 7th, 0·11: 8th, 1·44: 9th, 0·10: 11th, 0·48: 12th, 0·37: 15th, 0·72: 16th, trace: 18th, 0·18: 28th, 0·04: 30th, 0·17: October 1st, 0·35: 4th, 0·75: 5th, 0·02: 6th, 0·14: 20th, 0 07: 21st, 0·01 24th, trace: 25th, 0·20: 28th, 0·03: 30th, 0·02: 31st, trace: November 4th, 0·04: 5th, 0·13: 9th, 0·76: 10th, 0·07: 18th, 0·57: 19th, 0·63: 20th, 0·29: 21st, 0·11: 28th, 0·02: December 2nd, 0·02: 8th, 1·00: 9th, 0·02: 11th, 0·09: 20th, 0 02: 26th, 0·05: 29th, 0·34: 30th, 0·01: January 2nd. 1902, 0·05: 3rd, 0·17.

NOTES.—The first heavy rain came September 8th,—26 days after tests 1 and 2,—allowing ample time for the destruction of the old scales, but as stated below very few seemed to succumb. The light rain during the night after experiments 1 and 2 were made had no appreciable effect on the appearance of the trees.

The different experiments could be easily distinguished by the colour of the trees. Those in 1 and 2 showed a distinct olive tinge, which was not quite so distinct in 1 as in 2 on account of the greater amount of lime. Those in 5 and 6 were very white, 5 slightly dull as compared to 6, while those in 3 and 4 showed only a pecular light yellowish green tinge without any apparent coating. The lime coating was the coarsest of all and showed the greatest tendency to flake off, leaving considerable patches unprotected. The lime-salt wash was finer grained and adhered better than the lime. The lime-sulphur-salt wash was uniformly fine grained and adhered well. The same variations were observed in experiments 7 to 17, at Simondium.

The advantage in keeping the solution hot is due to the fact that some of the soluble compounds show a tendency to crystallize when cold, especially if left standing over night. In such case considerable boiling is necessary to redissolve the crystals, otherwise they are apt to be left in the tank. Even though kept in suspension by the constant agitation of the mixture, the crystals will not only lodge unevenly on the tree but be more easily removed by wind and rain.

OBSERVATIONS ON THE INSECTS.—Experiments 1 to 6 were carefully examined at frequent intervals and it soon became apparent that in all of the tests only a very small percentage of the insects had been killed,—possibly the imperfectly protected ones,—and that the eggs escaped without injury. Oviposition continued the same as on the untreated trees. In some cases the waxy covering showed a tendency to slough off, leaving the insects exposed. In one instance the unprotected female was ovipositing freely, the eggs lodging in the mass of surrounding scale. The eggs were hatching freely by October 1st, and it was with no little interest that the progress of the young scales was noted. Up to January 4th, 1902, none of them had survived on the trees sprayed with lime-sulphur-salt, experiments 1 and 2, nor on the trees sprayed with sheep-dip, experiments 3 and 4, although the second generation was appearing on the control trees. The young scales attempt to settle but die *in situ* and thousands of them remain on the bark for some time, apparently held in place by the mouth parts. On the trees sprayed with lime-salt or lime,—experiments 5 and 6,—the young have settled without any apparent difficulty, showing no appreciable preference for the patches where the coating had scaled off, indicating that lime-salt, or lime alone, has no special preventive value. It should be noted, however, that the lime, forming a granular coating on the tree, has a tendency to prevent the proper attachment of the waxy covering, thus causing a slight percentage of the young scales to slough off.

Although the coating on the lime-sulphur-salt trees is much finer than on the lime-salt, or the lime, trees, that in itself is not a satisfactory explanation, because on the trees treated with sheep-dip there is no apparant coating and the young scale die in the same way. The only explanation that suggests itself is that the soluble compounds were the essential part of the mixture and that the frequent light rains, though not heavy enough te remove them, dissolved them sufficiently to destroy the young scales before they could produce the protecting scale. The dead young scales vary considerably in size, suggesting that the larger ones emerged soon after one rain and the maller ones just before the next.

The weak point in the life history of *Diaspis pentagona* Targ. is the fact that the scale is formed very slowly, for some time consisting simply of long, irregularly matted, waxy filaments easily penetrated under the influence of rain.

Strangely enough, many of the overwintered scales live and oviposit till the beginning of the second generation. This great irregularity in development, together with the almost perfect protection by the scale, is the strong point in the life history of the species. On trees thoroughly sprayed with lime-sulphur-salt wash or sheep-dip, the only hope of survival seems to depend on the ability of the old scales to hold out until the rains reduce the soluble compounds of the wash sufficiently to render them harmless to the young scales. One important exception to this must be noted. On badly infested trees the scaly incrustation loosens slightly, enabling some of the young to settle down under it and be quite safe from the effect of the wash. This was strikingly illustrated at Simondium. The trees were carefully examined on February 18th, 1902, nearly six months after treatment, and no live scales were found except under the crust of old dead scales. Some of the females were ovipositing freely. That these parts were not missed in spraying is shown by the fact that lime was still distinctly noticeable. This indicates a short-coming on the part of the wash and suggests the possibility of confusing some of the first generation with the last of the overwintered individuals. Thus far, whale oil soap 2 pounds to the gallon of water (see notes below) is the only wash that has overcome this difficulty. The lime-sulphur-salt wash, however, is so much cheaper, and the number of scales harboured under the old crust is comparatively so slight, that the additional expense of whale oil soap seems hardly justifiable in combatting an insect which is already so generally distributed.

The notes on experiments 7 to 17 are in harmony with the observations made at Constantia. Thorougly drenching the trees with water in experiments 7 to 10 apparently had no injurious effect. Boiling the wash after adding the remaining lime did not enhance its value. The variations

in the amount of lime had no appreciable effect on the results. This is of practical importance, for it reduces the cost of the wash as well as the difficulty in application.

Cost of materials.—Good quick-lime in sealed cases can be procured of James Robertson and Co., Cape Town, for 42s. per 300 pound case; in 40 pound cases, for 2d. per pound. Saldanha Bay lime, in bags, can be procured of Evennett and Morton, Cape Town, for 3s. per 100 pound bag. Single bags, 3s. 6d. Sulphur can be procured for about 18s. per 100 pounds, and stock salt for 7s. 6d. per bag of 200 pounds.

Counting only the cost of material, the wash indicated by the formula can be prepared for 1½d. to 2d. per gallon. But since a wash prepared on the basis of 10 pounds of lime and 20 pounds of sulphur seems to be as effectual as one to which the extra 30 pounds of lime and the 15 pounds of salt have been added, the cost is reduced about one-third.

More extensive experiments will be made during the coming winter to fully test the reliability of the cheaper wash under varying conditions.

Resin Wash.

The wash was prepared according to the following directions, taken verbatim from Mr. Lounsbury's report for the year 1896. "The standard formula for resin wash is:—

Resin	24 lbs.
Caustic Soda (98 per cent.) ...	5 lbs.
Fish-oil ...	3 pints (2¼ bottles).

With water to make 100 gallons of diluted wash.

As 100 gallons is a larger quantity than many would care to prepare, the proportionate amounts of the ingredients for smaller quantities are given.

For dilute wash containing—

	50 gallons.	25 gallons.	10 gallons.
Resin ...	12 lbs.	6 lbs.	2½ lbs.
Caustic Soda	2½ lbs.	1¼ lbs.	½ lb.
Fish-oil ...	1¼ bottles.	½ bottle.	¼ bottle.

First crush the resin, which may be easily done by placing it in a meal sack and pounding it. Pour at least two-thirds of a gallon of water into the cooking vessel for

every pound of resin to be used, add the caustic soda and the oil and bring these to a boil. Then stir in the resin and keep this mixture well stirred while the resin dissolves. If the liquid boils over add a small quantity of cold water, but never much. The mixture at first is milky, but when the resin dissolves it becomes clear and dark brown, not unlike strong coffee. The boiling need not be continued over ten minutes when this stage is reached, and then water to bring the total quantity of the liquid above 21 gallons (when full quantity is made) should be added. The making of the wash is then complete.

It will be found an advantage to mark on the cooking vessel the exact height reached by the number of gallons to which the concentrated wash is diluted in the cooking. As stated, this should be above 21 gallons when the 100 gallon formula is used. The best height to mark and fill up to is that reached by 25 gallons; or if the quantities of the ingredients which have been taken are for 50 gallons of dilute wash, or 25, or 10, the proportionate parts of 25, that is, $12\frac{1}{2}$, $6\frac{1}{4}$, and $2\frac{1}{2}$, respectively. Then for use, one measure of this concentrated wash may be taken for each three of clear water, thus obtaining the proper dilution without measuring by the gallon."

For Red Scale.—Small orange, lemon and naartje trees at Simondium, ranging from five to eight feet in height, were selected for treatment. Two trees were sprayed with the winter wash ($1\frac{1}{2}$ times the summer or "standard" strength); four with the standard wash, cold; and twenty with standard wash, hot, August 29th. In the latter case eight of the trees were thoroughly drenched with water, two on the 1st, 2nd, 3rd and 4th days respectively, after spraying, to get some idea of the influence of a rain soon after the application. No effort was spared to reach all parts of the tree. The weather was fine and the trees, when dry, were very glossy. The drenching with a direct coarse spray of water made a decided difference, the trees afterwards appearing dull in comparison with the others.

When examined September 24th, all of the trees showed much dead scale, but also much live scale, especially on the rough bark. The scales on the leaves and young wood succumbed readily, while those on the rough bark were fairly resistant. The trees were last

examined February 13th, 1902. By this time the dead scales had been washed off and the live ones were the more conspicuous, and breeding rapidly.

No satisfactory statement can be made as to which one of the three applications was most effectual. Judging from Mr. Lounsbury's experiments in 1896, and the experience of fruit growers, as well as from the above tests, it seems safe to say that the Red Scale can be kept in check with standard strength of resin wash. But more than that need not be expected. The thorough drenching with water which some of the trees received was certainly detrimental, there being distinctly more live scale on those than on the others.

Tests were also made with a resin-soda and a resin-soda-soap wash. The omission of fish-oil, or replacing it with soft soap, seemed to make no decided difference in the effectiveness of the wash.

For White Peach Scale.—Eight large peach trees at the Government Wine Farm, Constantia, were sprayed August 15th, 1901: four of them with standard wash and four with winter wash ($1\frac{1}{2}$ times standard strength). So far as could be determined, the treatment was ineffectual in both cases, the young scales appearing in due time and settling without apparent hindrance. There seemed to be no after effect on the young, as with the lime-sulphur-salt wash, the sheep-dip and the whale-oil soap. It is safe to say that resin wash, either summer or winter strength, is quite useless for the destruction of the White Peach Scale during the dormant period.

For Woolly Aphis.—Three large, badly infested apple trees were sprayed August 29th, with winter, standard, and $\frac{1}{2}$ standard wash. Both the winter and the standard wash destroyed the lice almost completely, only two slightly infested twigs being found November 18th. The $\frac{1}{2}$ standard wash was not strong enough, there being much live aphis present November 18th. In this case, as in the other soap washes, paraffine emulsion, and mechanical mixture of paraffine and water, recorded below, the advantage of the stronger wash is not due merely to its killing the lice with which it comes in contact during the applica-

tion, but a greater amount of soap, or oil, clings to the tree and gradually penetrates the fine creases of the *aphis knots* as well as of the rough bark and destroys the young lice that are secreted there.

When the trees were examined February 13th, 1902, the aphis had made but little progress, the Shining Black Ladybird (*Exochomus nigromaculata* Goeze.) being present in sufficient numbers to keep it under control.

Soap Washes.

Whale Oil Soap.—Four tests with whale oil soap,—Owen's "U. S. Standard",—were made on large peach trees moderately infested with White Peach Scale, at the Government Wine Farm, Constantia, August 16th, using 1 pound to ½, 1, 2, and 4 gallons of hot water. There were four trees in each of the last two tests, two in the second, and one in the first. The meteorological record is the same as recorded under lime-sulphur-salt wash. On the tree sprayed with 1 pound to ½ gallon, the destruction was complete, no live scale, eggs nor young having been found up to January 4th, 1902. The tree was apparently uninjured but set only a light crop of fruit compared to the surrounding trees, showing that the fruit buds were injured. The weaker strengths were not wholly effectual. Live scale and eggs were found on the trees after the spraying and young scales appeared in due time. There was a distinct after-effect on the young scales, similar to the effect of lime-sulphur-salt or lime-sulphur sheep-dip, and was attributed to the film of soap on the tree being slightly dissolved from time to time by the light rains. Although the protection was not so complete as with the lime-sulphur-salt wash or the lime-sulphur sheep-dip, yet the scale was decidedly checked.

Small orange, lemon, and naartje trees badly infested with Red Scale, were sprayed with soap at the rate of 1 pound to ½, 1½, 3, 4, and 6 gallons of hot water, August 30th. One pound to ½ gallon of water was fatal to all of the scales, but the tree lost nearly all of its leaves within a month. Two months later the tree had recovered nicely and only one live scale could be found, possibly carried from some of the infested trees near by. One pound to 1½ gallons destroyed nearly all of the scales. About half of

the leaves dropped within a month. Very few live scales could be found February 13th, 1902, and the tree had completely recovered. The weaker strengths killed many of the scales, but not enough to be satisfactory, the trees being fairly well infested six months later.

Four large apple trees badly infested with Woolly Aphis were sprayed August 30th with soap at the rate of 1 pound to $1\frac{1}{2}$, 3, $4\frac{1}{2}$ and 6 gallons of water. The trees were examined September 24th and no live lice were found on the tree sprayed with 1 pound to $1\frac{1}{2}$ gallons. An occasional live louse was found on the tree sprayed with 1 pound to 3 gallons, while on the trees treated with the two weaker solutions numerous live lice could be found. By November 18th a few small colonies were found on the tree sprayed with the stronger solution, while on the others they were again making rapid progress.

Soft Soap.—Four small lemon trees badly infested with Red Scale were sprayed with soft soap (manufactured by David Dreghorn, Glasgow) at the rate of 1 pound to $1\frac{1}{2}$, 3, $4\frac{1}{2}$ and 6 gallons of hot water, August 31st. The trees were examined September 24th. One pound to $1\frac{1}{2}$ gallons killed about 85 per cent. of the scales, the live ones being on the rough bark. One pound to 3 gallons killed less than 70 per cent.; 1 pound to $4\frac{1}{2}$ gallons killed less than 50 per cent., while 1 pound to 6 gallons had almost no effect. Similar tests were made on young pear trees with Chiswick soft soap, but the results were less encouraging than with Dreghorn's soap on lemon trees. The two brands of soap were not analyzed and hence no explanation can be suggested from that source. None of the trees showed any signs of injury.

A large apple tree badly infested with Woolly Aphis was thoroughly sprayed with 1 pound of Dreghorn's soft soap to $4\frac{1}{2}$ gallons of water, August 31st. At the time of application it seemed to work very well, but three weeks later many live lice were present.

Hard Soap.—A small lemon tree infested with Red Scale was sprayed with 1 pound to 6 gallons, but without apparent effect. Stronger solutions were tried on young pear trees infested with Red Scale; but as in the case of Chiswick soft soap, the results were very indifferent.

Paraffine Emulsion.

The emulsion was prepared according to the Riley-Hubbard formula, using "White Rose" paraffine, 150° flash test, and blue mottled soap, as follows:—

Soap	...	...	1¼ pounds,
Paraffine	...	...	4 gallons,
Water	...	...	2 gallons.

The soap was dissolved in boiling water and, while hot, added to the paraffine away from fire, and emulsified by means of a spray pump with nozzle removed until the whole mass became gelatinous and no free oil was apparent.

For White Peach Scale.—Twelve large peach trees on the Government Wine Farm, Constantia, were sprayed August 15th, 1901. Three tests were made using one part emulsion to 2, 4, and 6 parts water. The dilute emulsion was applied while hot. The trees were carefully examined on August 20th, and plenty of live scale and eggs were found. By October 10th, young scales were present in abundance and settling without hindrance. Owing to the large percentage of dead scale present before the spraying, as indicated under lime-sulphur-salt wash, it was impossible to give a reliable estimate of the percentage of scales killed by the emulsion. Suffice it to say that none of the tests gave results at all satisfactory. The trees showed no signs of injury.

For Red Scale.—Small orange, lemon, and naartje trees, ranging from three to five feet in height, were sprayed with emulsion made according to the above formula, but in place of blue mottled soap "Gossage's Widnes Yellow" was used. The emulsion was not as perfect as with the blue mottled soap, a little more free oil showing on dilution.

Eighteen trees were treated with 1 part emulsion to 5, 7, 9, and 12 parts water. The trees were thoroughly drenched August 31st, 1901. When examined September 24th, there was much healthy scale on all of the trees and observations were discontinued. None of the trees showed any signs of injury.

For Woolly Aphis.—A large badly infested apple tree was sprayed with 1 part emulsion to 15 parts water, August 31st. It killed all of the lice with which it came

in contact, but it was not strong enough to penetrate the creases of the *aphis knots* and destroy the young lice. By September 24th, the tree was again thoroughly infested.

Mechanical Mixture of Paraffine and Water.

The Deming Company's "Success" pump with oil attachment, and "White Rose" paraffine, 150° flash test, were used. The indicator on the oil attachment was placed at the per cent. desired and the pump was then worked for a few moments to insure its having discharged any oil and water that might be remaining from a previous test. A sample was taken in the midst of each test. Where the percentage of oil in the spray was found to be at variance with that indicated by the gauge on the oil attachment, the exact amount is shown by the figures in parenthesis.

For White Peach Scale.—Four large trees were sprayed: one with 10, another with 20, and two others with 40 per cent., August 16th. Four days later there were numerous live scales and eggs on the 10 and the 20 per cent. trees, but on the 40 per cent. trees no live scales nor eggs were found, except a very few under the heavy incrustation of the old dead scales. The 10 per cent. mixture did not injure the tree; the 20 per cent. did serious injury; while the 40 per cent. killed one tree and seriously injured the other.

For Red Scale.—At Simondium, twenty orange and lemon trees were sprayed September 2nd: two with 5 (4·7), two with 7½ (9·3), four with 10 (11·9) eight with 15 (17·3), one with 20 (21·4), two with 25 (26·5), and one with 30 (32·2) per cent. None of the trees were injured by the treatment. The 5 and 7½ per cent. mixtures had very little effect. The 10 per cent. mixture killed about 50 per cent. the 15 per cent. about 90 per cent. of the scales, while the 20, 25, and 30 per cent. mixtures gave somewhat better results, destroying perhaps 95 per cent. or more of the scales. The trees were small ranging from 3 to 5 feet in height. The dense foliage made it difficult to reach all parts of the trees and hence they were of necessity somewhat oversprayed, thus making a slight accumulation of oil possible and perhaps accounting for the almost uniform results with the four stronger mixtures.

For Woolly Aphis.—A badly infested apple tree was thoroughly sprayed with a 5 (6·3) per cent. mixture, September 2nd. It seemed to be quite effectual and no greater strengths were tried. Eight days later a very few lice could be found. There was not oil enough to penetrate thoroughly all of the creases of the *aphis knots* and destroy the very small lice. By September 24th, there were occasional clusters of lice noticeable and by November 18th the trees were again fairly well infested.

Water Solution of Potassium Cyanide.

Four small lemon trees badly infested with Red Scale were sprayed with potassium cyanide dissolved in water at the rate of 1 ounce to 1, 2, 3, and 4 gallons, respectively. Half a pound of hard soap was added to the 3 gallon test. The trees were thoroughly sprayed, but the results were negative in each case.

Summary.

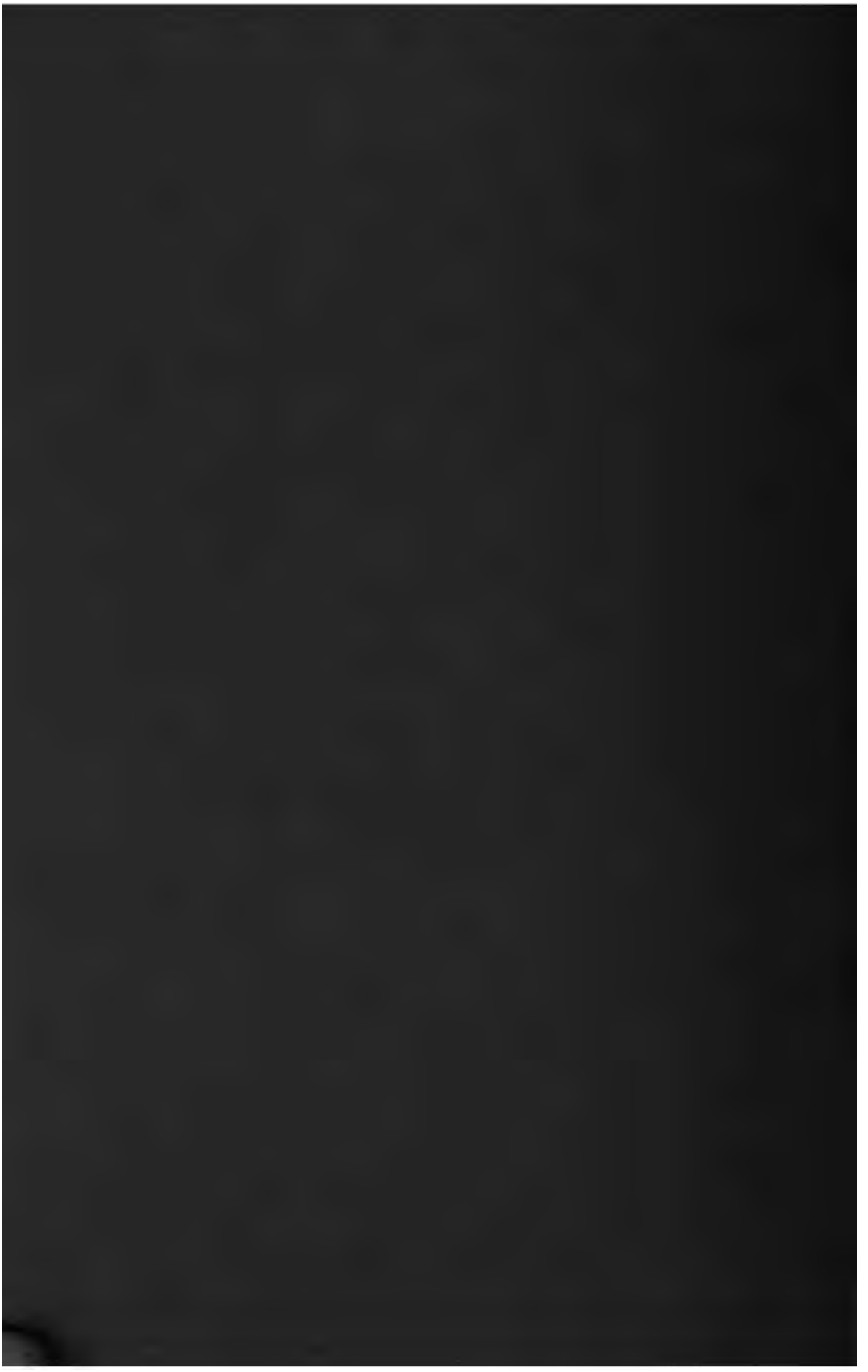
Lime-sulphur-salt wash, all things considered, is the best remedy for the White Peach Scale that we have tried thus far. It does not destroy the insects at the time of spraying but kills the young as they emerge and attempt to settle. The soluble compounds are evidently the essential part of the wash and hence the great excess of lime is unnecessary. Further tests must be made on a large scale to fully establish the validity of the above conclusions.

Resin wash, standard strength, is a cheap and effective remedy for the Woolly Aphis above the surface of the ground. Several applications will keep the Red Scale in check. It is useless for the White Peach Scale during the dormant period.

Soap washes are not satisfactory for use against the White Peach Scale during the dormant period, because of the expense of efficient strengths compared to lime-sulphur washes. One pound of soap to 2 gallons of water will keep Red Scale and Woolly Aphis in check. Whale oil soap gives somewhat better results than ordinary soft soap. Soap washes are valuable where few trees are to be treated on account of the ease with which they are prepared and applied.

PARAFFINE EMULSION is certainly of little value against the Red Scale, and also the White Peach Scale during the dormant period. Diluted with 15 parts water, it is not effectual against the Woolly Aphis, and if used stronger it would be more expensive than resin wash.

CYANIDE, in solution, at the strengths indicated, is useless for the Red Scale.



CAPE OF GOOD HOPE.

REPORT

OF THE

GOVERNMENT ASTRONOMER

FOR 1878.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

YEAR 1902.

CAPE OF GOOD HOPE.

Presented to both Houses of Parliament by Command of His Excellency the Governor.

1903.

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Cape Town, 3rd August, 1903.

THE HONOURABLE THE SECRETARY FOR AGRICULTURE.

SIR,—I have the honour to present herewith my report for the year 1902. Its preparation was unavoidably long delayed.

CHAS. P. LOUNSBURY, B.Sc., F.E.S.,
Government Entomologist.

TABLE OF CONTENTS.

Letter of Submittal. PAGE.

General Statement 1
Plant Import Regulations
Nurseries Inspection and Quarantine Bill

Contributions to Agricultural Journal 3

Natural Checks for Insect Pests 3
Hippodamia convergens.
Cryptolaemus montrouzieri.
Lecanium oleæ parasites.
Red Scale parasite.
Vedalia sendings.
Exochomus ladybird for Ascension.

Experiments with Insecticides 6
Sulphide Washes against White Peach Scale.
Injury to Trees by Sulphide Washes. 9

Various Washes against Bryobia mite ... ...
Insecticides tested.
Subsequent Rainfall.
Results of Winter Spraying.
Summer Remedies.
Conclusions.

Ticks and the Rhodesian Cattle Disease 16
Failure of Blue Tick to transmit the disease.
Success with another kind.

Ticks and Malignant Jaundice ... ..., 18
Confirmation of last year's work.

Ticks and Heartwater 20
A. Infection transmitted from Goats to Calves by the Bont Tick.
B. Infection transmitted from Calves to Calves by the Bont Tick.
C. Infection transmitted from Calves to Goats by the Bont Tick.
D. Infection transmitted from Calves to Sheep and Goats by Blood.
E. Failure to infect Horse by pathogenic Bont Nymphs.
F. Bont Tick Nymphs and Adults pathogenic indefinitely.
G. Infection derived in the Larval Feeding may fail to persist to the Adult Feeding.
H. Infection transmitted to Goats after immersing them in Cooper's Dip.
I. Progeny of pathogenic Bont Ticks appear non-infectious.
J. Recovered Animals lose capacity to infect Ticks soon after Cessation of Fever.
K. Recovered Animals may or may not react to Infection.
L. Bont Ticks dropped by recovered Animals during Febrile Reactions to subsequent Infection may or may not be pathogenic.
M. Blue Tick is non-pathogenic.
N. Blue Tick may cause a non-inoculable Fever.

Appendix 38
Table I. Temperature Records of Calves infected by Ticks from Goats.
Table II. Temperature Records of Calves infected by Ticks from Calves.
Table III. Temperature Records of recovered Heartwater Animals when again infected.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1902.

Presented to both Houses of Parliament by command of His Excellency the Governor

1902.

The work of the year consisted of several special investigations and the routine duties of attention to the entomological correspondence of the Department, the preparation of special reports on matters appertaining to insects, visits amongst farmers, contributions to the Departmental periodical publication, and the inspection of plant imports.

The Plant Import Regulations in force during the year were those proclaimed in 1896, but the delay in submitting this report enables me to now record that my recommendations for a revision of the regulations, urged for several years, have at last been adopted. We will hereafter, thanks to the change, be much less likely to introduce insect pests with importations of plants from abroad. Pests of fruit trees are still disseminated from

Colonial nurseries, but the Minister of Agriculture, on my recommendation, has promised to introduce the "Nurseries Inspection and Quarantine Bill" in the next session of Parliament. This Bill was drafted by the Board of Horticulture of the Western Province seven years ago, and has been repeatedly supported in these annual reports: that it has not been long enacted is much to be regretted. The insects found on imported trees were chiefly of species already established in the country, but several "finds" of species of scale insects quite foreign to the Cape were made. It is found that reliance cannot be placed on certificates accompanying consignments declaring the plants free from insects, and that they have been properly treated with hydrocyanic acid gas as a precautionary measure. Living scale insects and lepidopterous larvæ have been found on several such consignments. Under the new regulations all trees and woody plants are fumigated with the gas on arrival. Two additional chambers to facilitate this work have been provided at Cape Town.

The special investigations conducted during the year will be discussed in detail under separate headings. The Assistant Entomologist has demonstrated in a very thorough manner the efficacy of lime-sulphur wash for the control of the Bryobia mite of fruit trees, and has thrown important light on the action of this valuable but hitherto little used insecticide. Investigations into the transmission of heartwater of sheep and goats, malignant jaundice of dogs, and Rhodesian cattle disease, by means of ticks, have occupied much of my own time. It has been shown that heartwater is transmissible from goats to calves by means of the Bont Tick, and, *vice versa*, transmissible by the same agency from calves to goats, and calves to calves. Transmission of Rhodesian cattle disease by *Rhipicephalus sp. (appendiculatus?)* has been demonstrated, and evidence adduced that the common *Rhipicephalus decoloratus*, the presumed transmitter of ordinary redwater, is innocuous as regards this disease.

The contributions of original matter to the *Agricultural Journal* covered seventy-eight pages of letterpress, and were as follows:—

TITLE.	Form.	Issue.	Pages.
			Vol. xx.
First Report of Natal Entomologist ...	Notes.	Jan. 2	36-38
Daylight Fumigation	,,	,, 16	72-73
House Fly	Article	,, 30	185-194
Orthezia insignis	Notes	Mar. 27	427-428
Some New Tree Pests...	Letter	April 24	500-501
Flea Beetles	,,	,, 24	501
Fruit Moth	,,	May 8	553
Lecanium Scale on Peach	,,	,, 22	604
Longevity of a Species of Tick	Notes	,, 22	639-641
Lime, Sulphur, Salt Wash	Article	June 19	768-776
Paraffin Emulsion with Resin Wash ...	Notes	,, 19	776
			Vol. xxi.
Australian Bug	Letter	July	4
Orthezia insignis	,,	,,	5-6
Insect Eggs in Peach Trees	,,	,,	9-10
Fumigation under Box Covers	Article	,,	54-64
Potato Tuber Moth	,,	,,	78-82
Cyanide Gas Fumigation : Doses ...	,,	Aug.	146-148
Heartwater in Calves	,,	,,	165-169
,, ,, ...	Notes	Sept.	221-222
Pepper Tree Pest	Letter	,,	269
Death's Head Moth Superstition	Notes	,,	270-272
Plague of Ticks : Oil Spraying	Article	Oct.	337-345
Patent Box Closing Device	Notes	,,	348-350
White Ants	Letter	,,	363
Washes for Red Scale...	Article	,,	371-373
Plague of Ticks : Pumps for Spraying ...	,,	Nov.	427-433
Dipping *versus* Spraying	Notes	,,	433-434

NATURAL CHECKS FOR INSECT PESTS.

Under this heading it was last year announced that immense numbers of the aphic-devouring ladybird named *Hippodamia convergens* had been introduced to the Cape from California and liberated in localities where Woolly Aphis was abundant. The ladybird procreated once in South Africa, but so far as we have been able to determine, it completely died off in the new generation. During the past summer we were not able to find a single descendant from the hundred thousand or more specimens that had been liberated. At no time was there a

lack of food in the form of Woolly Aphis, and generally there was an abundance of other kinds of aphides, so it was not for lack of food that the ladybird failed to establish itself. Nor was any local circumstance responsible, for the failure was complete in the Paarl and Stellenbosch divisions as well as at the Cape. The only explanation I can suggest for the failure is that the insect probably requires a greater degree of cold for successful hibernation than the Cape climate affords. I understand that in California the insect is only found amongst the high mountains in the winter, where, owing to greater altitude and cover of forest vegetation, the cold is more constant than amongst the bare, rock-covered mountains to which the insect might retreat in the South-western districts of the Cape.

Cryptolæmus montrouzieri.—Thus far the attempts to get this mealy-bug destroying ladybird established out of doors in the Western Province have failed; but better fortune has rewarded the efforts made in the Eastern Province. Colonies were sent to the Curators of the Public Gardens at King William's Town and Graham's Town, and at both places the species established itself in Norfolk Island Pine trees, where it feeds upon a scale insect (*Eriococcus araucariæ*) allied to the mealy bugs. The mother colony at the office in Cape Town is still kept up, though at the expense of considerable time and trouble in procuring food for it. We expect to ultimately succeed in getting the species established in the Cape district, and anticipate that it will assist in suppressing mealy bug on guava, oleander and other evergreen growths, and also be of value in ridding the Norfolk Island Pine of its disfiguring scale, but we now have little hope that it will prove of practical importance in holding down the mealy bug of the grape vine.

LECANIUM OLEÆ PARASITE.—The *Scutellista cyanea* sent from the Cape to California to prey upon the Black Scale (*Lecanium oleæ*), the worst scale pest of that country, appears to have made an excellent start at its work. The Entomologist to the State Board of Horti-

culture, in an article published in the *California Fruit Grower* for January 17th, 1903, said:—

> "Seventeen of the parasites reached us alive but only four were females. . . . . We have succeeded with these beyond our most sanguine expectations, and six generations have been bred and distributed in all counties where Black Scale is troublesome. . . . . Colonies placed in orchards have gone through all their changes in the brief space of forty-seven days. This is extraordinarily rapid work. . . . . Colonies have been liberated upon orange, lemon, olive, prune, oleander, English holly and pepper trees, and in each instance the parasites have attacked the scale and the young maggots have been bred therein. This is certainly encouraging, as the celebrated *Vedalia cardinalis* positively refuses to eat cottony cushion scale (*i.e.*, Australian Bug) raised on laburnum and a few other trees and plants. . . . . In all my experience with parasitic and predaceous insects, I believe that *Scutellista cyanea* will prove to be one of the most valuable yet introduced into California."

The Western Australia and New South Wales Departments of Agriculture have both requested that they be furnished with colonies of this beneficial insect, and an attempt to meet their wishes will be made during the coming winter. So well is the scale kept suppressed at the Cape, however, that there is great difficulty in getting together sufficient parasitized material to make even a small sending.

The Red Scale parasite mentioned in last year's report has not yet given sufficient promise of importance in California to warrant the expense of its introduction to the Cape. It will not be forgotten about, however, and should it ultimately prove at all successful in checking the scale, no trouble will be spared to secure its establishment here. From the latest accounts there is reason to fear that it is identical with the inefficient parasite already present at the Cape, both East and West

Applications for *Vedalia* colonies are still received by the Department, and complied with as opportunity permits. No really serious outbreaks of the Australian Bug are known to have occurred anywhere in South Africa for many years now, and probably most of the colonies of *Vedalia* sent out are needless, the ladybird being so widespread that any outbreak is sure to be suppressed within a short time without any interference by man. If there is any exception, it is in exposed places like Vryburg. *Vedalia* is sent there every year from the office, but each year it is said to die off completely during the winter.

In compliance with an urgent request from Ascension, received through the Admiralty, several hundred specimens of *Exochomus nigromaculatus*, one of our beneficial ladybirds, were collected and despatched to that island. They were wanted to feed on the common Woolly Aphis of the apple.

EXPERIMENTS WITH INSECTICIDES.

White Peach Scale.

The experimenting with soluble washes for the destruction of the White Peach Scale (*Diaspis pentagona*), began in 1901, was continued during 1902. In the earlier year a wholly soluble wash of lime sulphide, without salt, proved as efficacious as the ordinary lime-sulphur-salt wash, which contains a large amount of lime in suspension, in addition to that combined with sulphur, and also contains salt; and it was desired to learn if the experience of another season would confirm the finding. Accordingly the experiments of 1901 were duplicated, trees in the same orchard at the Government Wine Farm being used. Unfortunately for the experiments, the season proved an unfavourable one for the scale insect, the pest dying off to a large extent on the control trees and the spring hatching being meagre, but as far as could be determined under the circumstances the cheap, easily-applied lime sulphide answered as well as the more expensive lime-laden complete wash.

The washes applied were: Ordinary lime-sulphur-salt wash prepared from forty pounds good unslaked lime, twenty pounds sulphur and fifteen pounds of salt, in full and half strengths, that is, diluted with water to fifty and one hundred imperial gallons respectively; lime-sulphur wash prepared from ten pounds good unslaked lime and twenty pounds of sulphur in full strength, fifty gallons, and half strength, one hundred gallons; and, finally, soda-sulphur wash prepared from

thirteen and one-third pounds 98 per cent. caustic soda and twenty pounds of lime (H. G. Webber's proportion) in the same dilutions. The lime-sulphur-salt and lime-sulphur washes were all cooked forty minutes, by which time all of the sulphur was in solution. The soda-sulphur washes were not cooked; the sulphur was first worked to a thin paste and then the caustic soda stirred in with the result of chemical reaction at once with evolution of considerable heat. The applications were made September 3rd, 4th, and 5th, which this season was a fortnight before the buds began to open. As before, the superintendence of the operations was left to Mr. C. W. Mally, the Assistant Entomologist.

INJURY TO TREES.—Although the experiments were not decisive in showing superiority in any one of the washes over the other two kinds against the scale insect, they proved useful by demonstrating in a most emphatic manner that these soluble sulphide washes may, under some conditions, prove decidedly injurious to the trees. Just what the conditions are we do not yet know with certainty, but it appears to us to be chiefly an unripened state of the wood at the time of spraying. On previous occasions of spraying with lime-sulphur-salt I have noticed that thin wood inside of the trees was sometimes damaged or even killed, but never before have I seen, nor have I ever heard or read of, such injury as befel many of the trees treated this time. Trees treated with both single and half strengths of all three washes were damaged, but the damage was greatest where the stronger washes were used and somewhat more noticeable on the trees treated with soda-sulphur than on those treated with the other washes. The injured wood included much of the terminal growth. In a few trees two-fifths to one-half of terminal twigs were killed back twelve to twenty inches, or to older wood, but in most the injury was confined to under one-third of the twigs. The fruit crop was very materially affected, and it was not until late in the season that the damage appeared to be overcome. The first observations were made September 15th, ten days after the spraying. Some of

the growth was already dead at this time and more was showing the injury by patches of dead bark, yellowish-brown in colour, at one or more places. These patches tended to enlarge and encircle the growth, thus killing everything beyond. Other twigs died back from the tops. The full injury was not apparent until six or eight weeks after the spraying. The injured trees are alongside trees unharmed by lime-sulphur-salt wash applied a year before, and are of the same variety (Constantia Beauty). This part of the orchard lies in a narrow valley closed in by tall oaks below. A small brook flows down the middle, and unquestionably many, if not all, the injured trees had too much water at their roots during the winter which was exceptionally wet. All of the peach trees in the valley have shown an unusual number of bare shoots both this summer and last, the buds failing to start at the proper time or even dying and dropping out. This abnormal behaviour of peach buds on many shoots is common in the Colony, and is usually attributed to unseasonably warm spells during the winter. But whilst the control trees had many of these leafless shoots this year, the wood in their case was sound and green when cut, not dead and sour of odour as was the injured shoots of the sprayed trees. The injury was therefore certainly due directly to the spraying whatever it may have been due to indirectly.

Fortunately, a small number of peach and nectarine trees on the hillside back of the valley were included in the experimental sprayings. Some of these are seedling and others grafted sorts, and all, though of bearing age, are much younger than the trees in the valley. They were sprayed from the same batches of washes and on the same days as the other trees, but not a twig on any one of them was injured by even the stronger washes. This shows conclusively, I think, that the washes were not at fault. These trees leafed out much better than those below, there being very few buds latent in starting. Altogether, therefore, we are inclined to the opinion that whilst directly due to the spraying, the injury was indirectly due to an unhealthy condition of

the wood at the time. It has been noticed that nursery stock fumigated late in the fall before the sap is down is apt to be damaged in a very similar way, whereas the same class of stock fumigated after the wood is fully dormant is not injured at all by much stronger gas.

Bryobia Mite.

For several years the Bryobia Mite has been becoming increasingly injurious in the newly established prune orchards of the Western Province, and so much damage was done in the season 1901-1902, that the Department of Agriculture was requested by the Board of Horticulture to have experiments undertaken with the view of determining the insecticides best adapted for its control. Arrangements were accordingly made with the Cape Orchard Company, Hex River, for experiments in their extensive prune orchards, and the proposed work put in charge of Mr. C. W. Mally, the Assistant Entomologist.

Insecticides Tested.—The tests made consisted of lime-sulphur-salt wash in single, two-thirds, half, and quarter strength; lime-sulphur wash (10 pounds lime and 20 of sulphur with 50 gallons of water) in single, two-thirds, half, and quarter strength; soda-sulphur wash (13⅓ pounds caustic soda, 20 of sulphur with 50 gallons of water) in single, two-thirds, half, and quarter strength; sulphur, 2 pounds simply mixed with 4 gallons of water; paraffin emulsion (Riley Hubbard formula) diluted respectively with two and a half, five, and seven and a half parts of water to one of concentrated emulsion; soft soap at the strengths of one pound to two, three, and four gallons of water respectively; hard soap (blue mottle) at the same strengths as soft soap; whale oil soap (Catawba Island make) at strengths of one pound to two, and three gallons of water; resin wash at full and at two-thirds of ordinary strength; Bordeaux mixture made by 6-6-25 formula; a solution made of four ounces white arsenic, four ounces caustic soda, one

pound soap and twelve gallons of water; and lastly, a half-in-half mixture of the arsenic preparation and Bordeaux mixture. The most heavily infested sections of the orchard was selected for the experiments. The trees here were nine years old. Blocks of eighteen were treated with the full strength lime-sulphur-salt, lime-sulphur, and soda-sulphur washes and smaller blocks, in most cases of nine or twelve trees, with each of the twenty-six other mixtures. No pains were spared to prepare the mixtures exactly in accordance with the formulas, and to apply them by the most thorough spraying possible. The only variation from the formulas was in the lime employed. Unslaked stone lime was purchased for the work, but on being opened at the orchards this was found so poor in quality that a high grade kiln slaked lime recently bought by the Company was substituted; one pound five ounces of this lime was used for each pound of unslaked lime called for in formula. The lime and sulphur washes were all boiled forty minutes. The soda and sulphur wash was made in accordance with the directions given by Mr. H. G. Webber in Bulletin 8 of the U.S. Department of Agriculture, Division of Vegetable Physiology and Pathology. There is no cooking required, the caustic soda being simply stirred into the sulphur after the latter is worked to a thin paste with water. The crust which forms at the bottom of the vessel was rejected. The preparation is thus easily and quickly prepared. Its application, too, is easy, since it is entirely soluble and cannot clog the nozzle or the intake strainer at the foot of the pump; but the solution is even more caustic than lime-sulphur and makes itself disagreeably felt when the spray drifts into one's eyes, and the skin of the hands is soon affected.

A series of all the sulphur containing washes was made and applied August 7th—11th. Heavy rains fell August 12th—16th, and so heavy were some of the showers and forceful the accompanying winds that it was deemed advisable to repeat all these tests to determine if the efficacy of spraying with such washes is in any way materially affected by a storm soon after the

application. A full series of all the washes was applied August 16th—22nd.

The rainfall for the season as recorded on the farm a short distance from the scene of spraying, was as follows:—August 12th, 0·17 inches; 13th, 2·09; 14th, 0·33; 23rd, 0·12; 24th, 0·11; 31st, 0·37. September 1st, 0·08; 9th, 0·63; 10th, 0·09; 11th, 0·22; 12th, 0·43; 18th, 0·04; 19th, 1·08; 22nd, 1·14; 23rd, 1·05; 30th, 0·23. October 1st, 0·04; 17th, 0·22; 27th, 0·07; 30th, 0·22; 31st, 0·07. No more rain then fell up to the New Year. The total to January 1st on the first spraying was 8·85 inches; and on the full series applied later, 6·26 inches.

Examinations were made about once a fortnight up to the first of the year, and subsequent ones in late January and early March. More frequent inspections were impracticable owing to the distance of the scene of operations from the office. Hex River Station is about 125 miles from Cape Town, and the orchards a few miles beyond. The full strength resin wash and the arsenic preparation caused some gumming from the bark, but this injury appeared to be soon overcome. The washes containing lime retarded the development of the buds by a few days, and those which darkened the bark, including all the soap washes, paraffin emulsion and resin wash, accelerated it; the trees done with the strongest whale oil soap wash were in full leaf at least twelve days ahead of untreated trees. However, as the season advanced, even the most backward trees appeared to catch up with the most forward. The setting of fruit seemed unaffected by the washes, and was quite satisfactory.

Results of Spraying.—Only the egg stage of the mite was present at the time of the spraying, and not any one of the washes seemed to have any appreciable effect on it. The eggs were deposited amidst old shells, and many both on sprayed and unsprayed trees failed to hatch, and hence it was impossible to make close comparisons; but a careful inspection a few weeks after the spraying gave the impression that the strongest soluble

sulphur, soap, resin and paraffin emulsion sprays had destroyed a small proportion of the eggs.

The eggs began to hatch in the middle of September, and at that time it seemed as if all the washes were failures. But from the experience of previous years, we knew to expect good results from the soluble sulphur washes at least, and hopefully continued the observations. The young mites swarmed in myriads about the swelling buds, and appeared to feed through the thin bark of the twigs as well as on the young foliage. Eggs were still hatching October 10th, but by this time the results of the spraying were becoming strikingly apparent.

The mites had almost disappeared from the trees sprayed with the strongest lime-sulphur-salt, lime-sulphur, and soda-sulphur washes, and had greatly diminished in numbers on the trees treated with the more dilute washes of these kinds; whilst on the trees sprayed with all the other mixtures the mites appeared almost if not fully as numerous as on the unsprayed trees. This relative condition was maintained throughout the season. Eggs from the new generation were laid late in October; some were found to be hatching on November 1st, and by the 11th nearly all had hatched. In early December eggs were again found in abundance, and also mites in every stage of growth. But up to January very few mites were to be found on the trees sprayed with the strongest sulphide washes, the one winter spraying apparently sufficing to protect the trees for the season. Towards the end of January an unseasonable storm, accompanied by very heavy winds, raged for several days; and when the orchard was next visited, it was found that few mites remained on any of the trees. Presumably, the storm was accountable for the great change. The foliage of the trees not protected by the strong sulphide washes had, a few weeks before, seemed doomed to fall before the fruit ripened; but thanks to the disappearance of the mites, enough of it remained to prevent any serious damage. Even in March, however, one could readily pick out the sulphide

protected trees at a distance by their abundance of bright green foliage.

The trees sprayed before the great storm of August 12th-16th with the sulphide washes remained almost as well protected as those sprayed later until about December. Then it was observed that the earlier sprayed trees were becoming more infested than the later sprayed ones; and, curiously, the increase of the pest was more marked on the lime-sulphur-salt than on the lime-sulphur sprayed trees. The soda-sulphur washes gave results somewhat inferior to and less lasting than the other two sulphides. Soda-sulphur is more expensive, though more easily prepared, and is more disagreeable to apply owing to its greater causticity. Only the strongest sulphide washes, that is those that were made with twenty pounds of sulphur to fifty gallons of water, were considered satisfactory. The weaker strengths were greatly superior to resin wash, paraffin emulsion, and the soap washes; but too large a proportion of the mites escaped for them to be considered really successful.

SUMMER REMEDIES.—It was obviously desirable to ascertain what wash answered best against the pest when the trees were in foliage, and with this object in view, applications of various preparations were made December 12th and 13th. These preparations were: lime-sulphur wash, ten pounds lime and twenty of sulphur, diluted respectively to contain these amounts to 150, 225, 360, 525, 900, 1,500, and 2,250 gallons of cold water; hard soap at the rate of one pound in six gallons of water; paraffin emulsion of Riley-Hubbard formula diluted with nine, and fifteen, parts of water; resin-soda wash (24 pounds resin, 5 pounds caustic soda, and 100 gallons water) at full, half, and quarter strength, tobacco infusion from roll tobacco at the rate of one pound to three, and one pound to six, gallons of water; and "Odamine," a tar product sheep dip, diluted with ten, and with twenty, parts of water.

The soap mixture killed all the mites that were hit; so apparently did the stronger paraffin emulsions, but at the next inspection many mites were still found on the

trees. The full strength resin wash did capital work, and the half strength did fairly good work; but the quarter strength and the weaker paraffin emulsion were both unsatisfactory. The stronger tobacco wash considerably decreased the pest but it did not wet well. The weaker was unsatisfactory. These contact destroyers all seemed to do best when applied in a fine spray through cyclone nozzles. The Odamine at both strengths was effectual in destroying the mites, but injured the foliage and fruit.

The lime-sulphur washes were efficient in proportion to their strength. None injured the foliage or fruit. Some mites were destroyed at once by the strongest wash, but in general the good results appeared gradually. On Christmas very few mites were found where the strongest wash had been used, and no great number where the second strength had been. The weaker strengths had done some good but not enough for satisfaction.

CONCLUSIONS.—The results reached justify the emphatic recommendation of the lime-sulphur wash for both summer and winter use against the Bryobia Mite. The wash is nothing more than the lime-sulphur sheep dip familiar to farmers made with different quantities of water. It is made by boiling twenty pounds of sulphur, with ten pounds of unslaked or the proportionate quantity of slaked lime, in water until the complete solution of the sulphur is effected, and by then diluting the preparation to the extent desired; for winter use against the Bryobia the dilution recommended is to fifty imperial gallons, and for summer use, to one hundred and fifty gallons. The wash may be applied hot or cold in this climate, but should not be allowed to chill when concentrated as a precipitation of crystals may then take place. The "ooze" may be rejected or stirred in for winter use, but should be rejected for summer use. The spraying in winter should be very thoroughly done under pressure from the pump heavy enough to drive the liquid into every crack and crevice in the bark; particularly should no part of the bark on

the young wood escape a coating. The summer spraying should be done with equal thoroughness but with a less forceful spray. As the action of the wash is almost entirely on the mites themselves, not on the eggs which alone are present in the winter, the winter application should be done as late in the season as is practicable.

The action of the summer strength wash recommended has only been tested on prune trees to which no injury at all was done. But for fear that the foliage of other kinds of trees be more sensitive than that of the prune, it is suggested that caution be exercised in treating other kinds until it is seen whether or not injury results. If injury does result, a more dilute strength should be used. Where lime is not easily procurable it may be advisable to use soda-sulphur wash in place of the lime-sulphur. It proved non-injurious to the prune trees treated during the winter in the experiments, but we do not know whether or not it can be used with safety during the summer at the strength relative to that at which lime-sulphur proved safe, namely, thirteen and one-third pounds of 98 per cent. caustic soda and twenty pounds of sulphur to one hundred and fifty gallons of water.

The experimental washes were all applied with Morrill and Morley "Eclipse" pumps, of which excellent design the Cape Orchard Company has several in use, each supplying two lines of hose. To enable them to cope at better advantage with the immense amount of spraying which they must hereafter do each season, I have recommended that a power spraying outfit be procured to supplement the hand pumps. One of these is now on order, the selection being a Goulds' Company triple action pump operated by a gasoline engine. I have also recommended the Company to set up a steam cooking plant, and this recommendation will probably be soon followed.

TICKS AND THE RHODESIAN CATTLE DISEASE.

During the latter half of the year continuous attention was given to experimental work bearing on the transmission of the serious cattle disease that since the latter part of 1901 has been raging in Rhodesia. The disease is considered to be redwater by the various veterinary authorities who have thus far studied it, but several marked distinctions can be drawn between it and typical redwater, and therefore a distinctive name for it, such as the one used here, is deemed desirable. No experimental work has been undertaken in South Africa to affirm the observation made in America and Australia that redwater is transmitted by ticks, but the evidence to this effect, obtained in practical experience at the Cape, is most convincing. It seems quite certain that the most common cattle tick of the country, the so-called Blue Tick, is associated with the disease; indeed, Dr. Koch, in his redwater investigation in German East Africa, six years ago, produced the disease in a clean area through the agency of what was, with little reasonable doubt, this particular species of tick. The scientific name of the tick is *Rhipicephalus decoloratus*. It is very closely allied to the species of ticks that are recognised as transmitters of redwater in North and South America and Australia.

Through the kind services of Mr. William Robertson, Bacteriologist of the Cape Agricultural Department, who studied the Rhodesian cattle disease at Salisbury last June and July, and those of Mr. C. E. Gray, the Chief Veterinary Surgeon of Rhodesia, and of his staff, this office has received many lots of living ticks taken from cattle suffering from the Rhodesian disease. Most of the ticks have been of the common blue species, and it was quite expected that the progeny of these would give rise to the malady. But although five different lots, received at different times from different parts of Rhodesia, have been tested on what are unquestionably

susceptible cattle, *this common cattle tick (Rhipicephalus decoloratus) has failed to produce any fever.*

The number of ticks applied from two of the lots was very large, and it is difficult to conceive how the animals escaped infection if the ticks were pathogenic. The parent ticks that gave rise to the first lot tested were taken by Mr. Robertson from a case of the disease which he himself diagnosed. Three animals were heavily infested, and some hundreds of female ticks fed to repletion and dropped from each of these.

Very few of the different lots of ticks received from Rhodesia have consisted entirely of *Rhipicephalus decoloratus.* Often specimens of the Bont Leg Tick (*Hyalomma aegyptium*) and the Red Tick (*Rhipicephalus evertsi*) were included, and almost all the lots contained specimens of one or more species of *Rhipicephalus*, which were quite new to me; part of the last are probably to be referred to *Rhipicephalus simus.* The progeny from two lots of *Rhipicephalus evertsi* were tested but failed to produce fever. This species of tick first drops from the host after the completion of its nymphal feeding and the specimens applied were not tested in the final stage, they being destroyed after they came away as nymphs. The progeny from two lots of *Rhipicephalus simus* (?) were also applied, but not a single specimen appeared to feed; if any did attach they failed to communicate the disease.

Nymphs of *Rhipicephalus sp.* accompanied two sendings. These were few in number and were taken at the time to be nymphs of *Rhipicephalus evertsi.* They came from sick cattle during the middle of October. The two lots were mixed, and after about a month the change to the adult stage was complete. On November 27th all the active specimens, five females and two males, were liberated within a cloth on the leg of an ox. The two males and one of the females attached. Three of the other females, and probably the fourth as well, were crushed under foot and thus thrown out of account. Fifteen days after the application of the ticks fever appeared, and four days later *organisms characteristic*

of Rhodesian cattle disease were found in the capillary blood by Mr. Robertson. The temperature remained high for twelve days and then for a day fell to normal; on the following day, December 26th, the animal died. Dr. Hutcheon and Mr. Robertson conducted a *post-mortem* examination, and both pronounced the appearance of the organs to be typical of the Rhodesian malady as opposed to ordinary redwater. Thus it has been demonstrated that the disease is communicated from animal to animal through the medium of ticks. Whether the infection in the one case produced was derived by the transmitting ticks in their nymphal feeding or whether it came to them through the egg stage is not known. But, however the infection was derived, the facts remain that *adults* transmitted it and that these were of a species having no close affinities with the common species presumed to be the carrier of ordinary redwater. There is no need now to speculate on the significance of these facts as further investigations are in progress.

TICKS AND MALIGNANT JAUNDICE.

'An investigation of the association of the common South African Dog Tick (*Hæmaphysalis leachi*) with the widely spread canine disease, malignant jaundice, formed as important part of the work for 1902 as it did for 1901. The work has not yet been carried to a stage at which it can be conveniently discontinued, and until it has been, a detailed report will not be submitted, The main conclusions recorded in last year's report have been abundantly verified and satisfactory progress made on new ground. A striking example of the peculiar and extraordinary fact that the infection of the disease is transmitted by the tick *only* when it is in the *adult* stage, and then only when its maternal parent imbibed infectious blood, was afforded by the infection of two puppies. An immense number of ticks that were progeny of females taken off a sick pointer in July were

fed on these pups as larvæ and nymphs. No attempt was made to count the ticks, but probably over twenty-five thousand larvæ were applied and at least five thousand nymphs. Despite the heavy infestation the puppies suffered very little; indeed they evinced no discomfort, eating and drinking and playing together as usual and not scratching at the ticks. Different batches of the two stages were fed on them between November 1st and December 21st, and the worst noticeable effect was to cause a decrease of a few ounces in weight each time, losses which were quickly made up in intervals of rest from the infestation. On December 22nd both were infested with some of the same ticks as adults, twelve females being applied to each. These adult ticks, it was anticipated, would transmit infection inherited from the parent ticks taken from the sick dog. And they did. In ten days both of the little animals were in fever, and after lingering prostrate for a few days, both died of most pronounced malignant jaundice. It has been found that both male and female ticks transmit the infection, and that ticks that crawl from dogs that have died from the disease may convey the infection to other dogs. In the latter case, the infection is not from the animal the ticks have recently left, but still infection derived through the egg stage from the last generation. The progeny of females engorged on a convalescent dog may be wholly innocuous in all stages, and the same is true of the progeny of ticks from long recovered dogs whose blood, when inoculated, in quantities of 2 c.c. and above at least, is highly virulent. Further, not all the progeny of ticks engorged on actually sick animals seem infectious, and it is conjectured from the evidence obtained that the progeny become infected in proportion to the extent of the infecting organisms in the blood imbibed by the mother tick. If, for instance, the mother tick comes from a sick dog, whose blood is swarming with the *Piroplasma* organisms, all or nearly all of her progeny probably share in the division of the infection, and thus are made capable of transmitting the disease; while if the mother tick comes from a healthy recovered dog, in whose blood

it is impracticable to demonstrate the existence of the organism by microscopic examination, few or perchance none of the progeny may receive any of the infection and thus become pathogenic. The severity of the disease, when transmitted by ticks, seems not to be influenced by the number of the ticks that transmit the infection, that is, by the *quantity* of infection, but to be largely governed by the *quality* of the infection the ticks transmit, be these few or many. A young jackal has stood infestation with a large number of pathogenic adult ticks and also subsequent inoculation with blood from a sick dog without exhibiting any manifestation of the disorder. The ticks fed quite as well as they would have done on a dog.

TICKS AND HEARTWATER.

The room for profitable research in determining the relations that exist between ticks and heartwater appears to be yet far from exhausted, and the present notes, like those submitted in the annual reports for the two previous years, are principally intended as a record of the progress made in the period reviewed. For convenience in reference, the chief features of the year's studies will be presented under suggestive sub-headings.

A. INFECTION TRANSMITTED FROM GOATS TO CALVES THROUGH THE MEDIUM OF THE BONT TICK.—The intention to test heartwater pathogenic ticks on calves was announced in last year's report (p. 36). The chief circumstances which led to the test were (1) the recorded evidence of Mr. John Webb before the Cattle Diseases Commission in 1876 that calves began to do badly coincidently with the appearance of the Bont Tick (1901 report, p. 39), (2) a note in a report from the Magistrate of East London, in 1875, that sheep and calves were becoming increasingly difficult to rear in the western wards of his district (1901 report, p. 33), and (3) the assertion made in an official minute by the Colonial

Bacteriologist that heartwater in small stock was identical with "imapunga" in cattle.

1. Ox No. 1, bull calf, about six months old, received from Elsenberg, March 15th. Infested, March 29th, with one hundred Bont Tick nymphs taken as engorged larvæ from goat No. LXIV. when dying of heartwater, March 6th. The ticks were liberated within a stocking drawn over a foreleg: forty-seven were recovered after engorgement and probably many more fed as crushed remains were found underfoot. Fever set in April 18th, twenty days from the application of the ticks, and from then on the temperature remained abnormally high. On the 21st the appetite failed and on the next day the animal was found prostrate on its belly, suffering greatly. It died at night-fall, and on the following morning was opened by Dr. Hutcheon. The mesentery was much inflamed, the kidneys were dark and congested, but all the other organs were found practically normal in appearance. The lesions of heartwater, as usually seen in sheep and goats, were wholly absent beyond a few small petechiae in the heart. Smears were taken from the blood and from various organs, but Mr. Wm. Robertson (the Bacteriologist of the Department) found no organisms in any of these under the microscope.
2. Ox No. 2, bull calf, about six months old, received from Elsenberg, March 15th. Infested with same number of ticks from goat LXIV. and at the same time as Ox No. 1. About seventy fed to repletion and were recovered. Fever appeared April 18th as in the other case, but abated after twelve days without at any time making the animal prostrate. Between April 23rd and the 27th very little food was taken.
3. Ox No. 5, heifer calf, about six months old, received from Elsenberg June 4th. Infested June 14th with one hundred Bont Tick nymphs, taken as engorged larvæ from goat LV. when dying of heartwater March 17th. Seventy-one were recovered alive after feeding, and probably many more fed to repletion but were crushed underfoot in bottom of stocking. Fever temperature prevailed July 6th to 15th except July 9th to 11th when readings were about normal. No visible indications of illness were shown until the 14th when appetite became small and animal was seen to be falling off in condition; it rallied rapidly after the lapse of fever.

As will shortly be shown, the infectious nature of the fever produced in all three of these animals was proved by the effects of inoculation of blood from them into goats; and subsequent events have shown that the fever was certainly that of heartwater. Nos. 2 and 5 are alive at the time of writing. The temperature readings of all three animals during the critical period of the test and for a few days before the application of the ticks are given in Table I. of the Appendix.

B. Infection Transmitted from Calves to Calves through the Medium of the Bont Tick.—Bont Tick larvæ were applied to Oxen Nos. 1 and 2 as soon as these animals were found to be in fever. No. 1 died before the larvæ applied to it had time to feed to repletion, but numerous engorged larvæ were recovered from No. 2 on and about April 22nd. Some of these ticks, as nymphs, were tested on calves as follows:—

1. Ox 3, bull calf, about six months old, received from Elsenberg, May 2nd. Infested on June 6th with about one hundred Bont Tick nymphs off Ox No. 2 about April 22nd. Thirty-three or more fed to repletion. The temperature readings were abnormally high almost from the start, but an unmistakable fever period, with loss of condition and lack of appetite lasted from July 1st to the 11th; after this period the animal improved in condition and its temperature readings approximated the normal.
2. Ox 4, bull calf, about three months old, from Elsenberg, received May 17th, and at once infested with about fifty Bont nymphs off of Ox No. 2. None of these ticks attached, probably because they were applied before the chitin of their mouth parts had had time to properly harden. Forty more ticks of the same lot were liberated in the stocking on May 27th, and of these twenty-two fed. Fever appeared June 18th but did not become pronounced until several days later. A complication of purging came on as the animal weakened and ceased to feed. Recovery became improbable and to end the little animal's misery it was despatched on July 3rd. The lungs and heart were found to be quite healthy, and there was little to suggest heartwater as it is ordinarily seen in sheep and goats. The fourth stomach was ulcerated and the intestine much inflamed, lesions possibly due to the complication.

The fever in both these cases was doubtless heartwater communicated by the Bont Tick nymphs from No. 2. As is shown under D below the disease was transmitted to goats by blood drawn during the fever interval. The severity of the disease in No. 4 was doubtless due largely to the unfortunate bowel complication. The temperatures recorded from both animals are shown in Table 2 of the Appendix. The abnormally high readings for No. 3 before the proper fever period may have been due to the inoculation of this animal a month before (May 7th) with blood supposed to contain a species of *Trypanosoma*. The inoculation was not followed by any appearance of this organism in the blood stream, but the temperatuare soon became abnormally high, and remained so until after the attack of heartwater. The animal is still under observation at the time of writing, and appears quite healthy.

C. INFECTION TRANSMITTED FROM CALVES TO GOATS THROUGH THE MEDIUM OF THE BONT TICK.—The ticks for these experiments came from Oxen Nos. 2 and 5 during their respective fevers, which it should be borne in mind were of a mild character and from which recovery was rapid.

1. Goat No. LXII., Angora cross ewe, from Stellenbosch in March. Used during April for a test of the Blue Tick. Infested May 13th with about thirty Bont Tick nymphs from Ox No. 2 in latter part of April. Only one specimen attached itself. Forty more of same lot applied May 20th. None of these appeared to become attached. Forty more applied May 27th, and this time at least twelve fed. Fever became manifest June 8th, and death followed on June 12th. It is uncertain which of the three batches of ticks transmitted the infection.

2. Goat No. LXIII, Angora cross ewe, from Stellenbosch in March. Used during April for a test with the Blue Tick. Infested May 13th, May 20th, and May 27th with the same number of ticks, and these of the same lot, as were applied to LXII. At least four of the second batch and sixteen of the third batch fed to repletion. Fever appeared June 12th and death followed on June 17th.
3. Goat No. LXXIII., Angora cross ewe, from Stellenbosch May 9th. Infested May 14th with thirty Bont Tick nymphs from Ox No. 2, and of these three bit. A second batch of same ticks, numbering forty, applied May 27th, and of these at least twenty fed to repletion. Fever appeared June 14th and terminated fatally June 19th.

No doubt was entertained that the respective fevers were the result of infection communicated by the ticks, but the uncertainty of the incubative period led to a repetition of the test on one goat with ticks from the same lot.

4. Goat No. LXXIX., Angora cross kapater, received June 13th from Faure. Infested June 21st with forty nymphs. Only part of them attached and none of these came away engorged until July 4th. Eleven recovered. Fever appeared July 13th and terminated fatally July 16th.

The ticks applied to all four of these animals were liberated within stockings of stout calico tied securely about the leg above the knee and above the foot. Ticks of this kind attach fairly well to the legs of goats, but they take much longer to get their fill of blood than do specimens that attach to the trunk of the body or on the thighs. Many specimens on the body often succeed in filling out within five days, and few take longer than eight, whilst few on the shins and feet take less than a full week, and many from ten days to a fortnight, and some much longer. It is not yet known just when the infection of heartwater is transmitted; but it is now established that infections by ticks applied to the legs generally take several days longer to produce the disease than infections by ticks applied to the udder or elsewhere on the belly. The ticks used to infect cases 1 to 4 above had all been kept in the incubator to hasten the metamorphosis from larva to nymph; others that had come from Ox No. 2 at about the same time were allowed to transform at the ordinary temperature of the office, and specimens of these were used for the three following tests.

5. Goat No. LXIX, Angora cross kapater. received from Stellenbosch, May 10th. Used for various tests of questionably pathogenic ticks and blood for over six months. Infested December 31st with thirteen Bont Tick nymphs that as larvæ had fallen from Ox No. 2 on April 22nd. One recovered on the eighth day and four more on the fourteenth. Fever appeared January 14th and terminated fatally January 17th.

6. Goat No. LXXXVII.. Angora cross kapater, from Faure in late November. Infested December 2nd with twenty Bont Tick Nymphs from Ox No. 2, April 22nd. Twelve recovered on December 10th and two more two days later. Fever appeared December 11th and terminated fatally December 20th.
7. Goat No. LXXXVI.. Angora cross kapater, from Faure in late November. Infested, without producing fever, with Bont Tick adults during December. (See H). Infested January 22nd with four Bont Tick nymphs from Ox No. 2., April 22nd. Three removed when nearly engorged on January 28th. Fever appeared February 3rd and terminated fatally February 7th.

Incidentally, cases 5, 6 and 7 show that the ticks retain the capacity to infect indefinitely, and are ready at any time to transmit the disease. The four ticks used on case 7 were the sole survivors of the nymphal ticks from the ox. They fell from the ox on April 22nd, 1902, and were applied to the goat just nine months later. To one unfamiliar with the habits of ticks, it would seem almost incredible that an active creature could live so long a period without food. The harbouring of the infection of the disease does not appear to exert any injurious effect on the health of the tick.

Whilst Ox No. 5 was in fever a number of non-pathogenic Bont Tick nymphs were fed on it, the ticks thus, presumably, being made pathogenic. To further affirm that the disease was transmissible from calves to goats through the medium of the Bont Tick, some of these specimens were used for the following test:—

8. Goat No. LXXXVIII., Angora cross kapater, from Faure about December 1st. Infested on December 22nd with twenty-five males off Ox No. 5 as nymphs July 15th to 18th. Nearly every specimen attached. Fever appeared January 5th and terminated fatally January 9th.

Thus it was demonstrated that the adult tick, like the nymph, may transmit the infection from calves to goats just as is the case from goat to goat; and, further, this one test shows that the males are pathogenic when applied alone.

It must now be mentioned that although the goats in this series of tests all sickened and died from the effects of infection transmitted by the ticks applied to them, the lesions found in cases 1, 2, 3, 4, and 7 at the *post mortem* examinations did not include a great excess of fluid in the heart-sac. This lesion has almost always been found in sheep and goats that have succumbed to infection transmitted from other sheep or goats, either

by ticks or blood, and is the feature from which the disease takes its name. Neither was there any fluid in the thoracic nor abdominal cavities in these cases as is often true in ordinary heartwater. Case 5 was not opened, whilst cases 6 and 8 were characterised by a great excess of pericardial fluid. The absence of the prominent lesion of ordinary heartwater in the first cases aroused a little doubt at the time as to the identity of the disease; but all doubts have since been dispelled, as will be apparent later.

D. INFECTION TRANSMITTED FROM CALVES TO SHEEP AND GOATS THROUGH THE MEDIUM OF INOCULATED BLOOD. —The tests grouped under this heading really preceded those grouped under C in point of time. They were conducted to determine as quickly as possible whether or not the calves used in the A and B tests were actually infected with heartwater by the heartwater pathogenic ticks that were applied to them. It must be remembered that heartwater cannot be determined by microscopical examination of the blood or by any special train of symptoms.

1. Goat No. LIX., Angora cross ewe, received from Stellenbosch in March. Inoculated intravenously April 21st with eight c.c. blood from Ox No. 1. Fever appeared April 29th and terminated fatally May 2nd.
2. Goat No. LII., Angora cross ewe, from Stellenbosch, October 29th, and for several months used for various tests without producing heartwater. Inoculated intravenously April 21st with 8 c.c. blood from Ox No. 1. Fever appeared May 2nd and terminated fatally May 4th.

Except for the enlargement of the mesenteric glands, a slight softness of the spleen and petechiae on the walls of the heart, no abnormal features were observed when these animals were opened, nor were organisms of any kind found in smears made and examined by Bacteriologist G. W. Robertson, of the Medical Officer's Department. During their fevers both animals behaved as they would have if suffering from ordinary heartwater, the heart action becoming rapid but very weak, and fits occurring towards death. The absence of the "heartwater" lesion in the first case led to the inoculation of two goats from the second as soon as the fever appeared. These second remove animals fevered and died as had

the first; but from one of them two more goats were infected, and from one of these two more, and thus on until the disease had been passed through six series of goats. Every one of the animals succumbed between eight and fourteen days from the time of its inoculation. The second removes showed slightly inflamed intestines. The third removes showed acute inflammation of the fourth stomach, intestines, and brain. One of the fourth removes showed what was anxiously awaited—lesions that if observed in a goat or sheep opened on the veld would have been pronounced those of heartwater; there was an excess of fluid in the heart-sac, and fully six ounces in the thoracic cavity. The second fourth remove was sent to Veterinary Surgeon Borthwick, at Somerset East, who reported that at death he found an ounce of fluid in the heart-sac. It was intended that Mr. Borthwick keep up the strain, but he was called away and was obliged to return the fifth remove, one goat only, to Cape Town. At its examination, typical heartwater lesions were again found. There was a small quantity of effusion in the chest, and about one and one-half ounces in the heart-sac; the interlobular spaces of the lungs were slightly distended, and there was only slight congestion of the intestines and kidneys, and also very little inflammation of the brain. One of the sixth removes had between four and five ounces of fluid in the heart-sac and about one and one-half ounces in the chest, but the fourth stomach and almost the entire length of the small intestine was acutely inflamed. The other sixth remove yielded no excess of fluid from the heart-sac, but a small quantity had gathered in the abdominal cavity; the intestine was but slightly inflamed.

The Colonial Veterinary Surgeon, Dr. D. Hutcheon, took a keen interest in this part of the work, and personally made many of the *post-mortem* examinations. When the first one of the sixth removes died he was quite convinced that we were dealing with heartwater only, and not with any previously unrecognised specific disease as was somewhat feared from the atypical lesions of the early cases.

Ox 2 came into fever at the same time as No. 1, and the blood was used to inoculate two sheep.

3. Sheep LXVII., merino ewe, from the Karroo, purchased in town about April 1st. Used during April by Veterinary Department in experiment with malarial catarrhal fever. Inoculated intravenously April 25th with 5 c.c. blood from Ox No. 2. Fever appeared May 2nd and on May 5th organisms of catarrhal fever found in blood. Death took place May 11th. No lesions of catarrhal fever found, but pericardium filled with fluid as in typical heartwater. No other lesions of note.
4. Sheep LXVIII., merino wether, from the Karroo, purchased in town about April 1st. Used during April in experiment with malarial catarrhal fever. Inoculated intravenously April 25th with 5 c.c. blood from Ox 2. Fever appeared May 6th and continued for one week without causing prostration or entire cessation of feeding.

The recovery of this sheep from the disease proved most fortunate. Having come from the Karroo, it was doubtless at first susceptible to heartwater; and were this disease from the calves *not* heartwater, then the recovered animal would, in all probability, be still susceptible, whereas if the disease were heartwater it would probably resist further infection. It was put to the test as follows:—

Infested June 14th with thirty-five Bont Tick nymphs from Goat LV. when dying of heartwater. Twenty at least recovered after feeding. No rise of temperature occurred.

To make certain that the ticks were actually pathogenic, twenty-five from the same lot had been placed on a lamb, May 13th. Eleven at least fed. Fever appeared May 28th, and proved fatal June 1st. Still further proof that the disease transmitted to the calves, and from them back to sheep and goats, was purely heartwater, was obtained by inoculating this sheep, in company with a goat that had recovered from an attack of heartwater, and also with a control sheep, with blood drawn from Goat No. LVI. shortly before its death from infection through blood from Ox No. 5 (see K). Both this sheep and the goat resisted the infection transmitted, whilst the control sheep, inoculated intravenously with 5 c.c., as were the others, sickened and died. Since then both animals have twice resisted heavy inoculations with virulent blood of a purely goat strain of heartwater. Immunity to the goat strain is, therefore, immunity to the calf strain and *vice versa*.

The fever of Ox 3 was confirmed by passing its blood into a goat.

5. Goat LXXXI., Angora cross, from Faure, June 13th. Inoculated intravenously July 10th with 5 c.c. blood from Ox 3 in fever. The temperature rose July 20th and goat died in typical heartwater fit on following day. Other than slight congestion of brain, fourth stomach, and intestines, and a somewhat enlarged and soft spleen, lesions were absent.

The fever of Ox 4 was also confirmed by passing blood into a goat.

6. Goat LXXX., Angora cross, from Faure, June 13th. Inoculated intravenously June 25th with 5 c.c. blood from Ox 4 in fever. The temperature rose July 8th and the animal was found dead on the morning of the 10th. This time the prominent lesions were an effusion of six to eight ounces typical heartwater fluid in theracic cavity, a soft spleen, severely inflamed fourth stomach, and slightly inflamed intestines.

The fever of Ox 5 was similarly confirmed.

7. Goat LVI., Angora cross, from Stellenbosch, December, 1901. Inoculated intravenously July 18th with 5 c.c. blood from Ox 5 in fever. The temperature rose July 28th and the animal succumbed, after having typical fits, August 2nd. The lesions were those of heartwater but were not very pronounced.

The experiments, altogether, show that heartwater affects young cattle in common with sheep and goats. They show that the disease is transmissible from goats to calves, and from calves to goats, and calves to calves. But it is obvious that the disease is much less serious amongst calves than amongst Angora goats. Of the five calves infected by ticks, two only succumbed, and the death of one of these appeared to be due more to complications than the actual disease; whilst every one of the eight goats infected with ticks from these five calves died after a short illness. It is planned to apply pathogenic ticks from goats to grown cattle during the coming year to determine if they, like young cattle, are susceptible.

E. Failure to transmit Infection to Horse by pathogenic Bont Nymphs.—The success in transmitting heartwater to cattle led to a test of pathogenic Bont nymphs on a leg-injured Cape Town horse. Over one hundred were applied, July 9th. They bit very well, and by the 17th ninety-seven had been recovered after engorgement. An application of oil was then made to destroy what ticks remained. Observations were continued for six weeks, during all of which time the tem-

perature of the animal remained normal except during one day when colic raised it for a few hours. That the batch of ticks, from which the specimens applied to the horse were taken, was pathogenic was demonstrated by producing fever in Ox 5 and Lamb LXXIV. by some. The lamb died of typical heartwater, although only eleven ticks engorged on it. Further evidence was secured by producing fever in Goat LXXXII. by the ticks taken from the horse. (See G).

F. Bont Tick Nymphs and Adults pathogenic indefinitely.—All the experience with heartwater pathogenic Bont ticks tends to show that they remain continuously pathogenic until they feed again. It matters not whether they feed just after they moult or six months subsequently. As will be shown under H below both nymphs and adults have infected goats after being without food from six to eight months; and under B in the 1902 an instance of adults infecting after eight months was given.

The incubation period in sheep and goats following tick infection is somewhat variable. When the ticks attach to the trunk of the body, it is seldom more than fifteen days, and sometimes as short as eleven; when the attachments are on the legs it is generally from fifteen to eighteen days—occasionally even longer—in one case recorded (Goat LXXIX.) it being twenty-three days. It is thought that the infection is transmitted at once by the ticks despite the lengthened incubation period from leg infestations. However, it should be mentioned that the ticks take far longer to feed when attached to the legs of goats below the knee (where they are usually confined) than when attached to the thighs or trunk. When fed on the latter parts the first to fall are generally off by the sixth day, whilst when fed low on the legs, it is generally ten days before any come off. In the case where the incubation period was twenty-three days, none of the ticks were recovered until the thirteenth day. These remarks apply only to goats and sheep. The ticks feed up more rapidly on the legs of cattle.

Failures to infect, when Bont nymphs or adults fed last on heartwater-sick animals are used, are very infrequent in our experience, and during 1902 were confined to instances in which specimens from calves were employed (see cases 1, 2, and 3 under C); and in even these, infection resulted when more specimens from the same animals on the same days were applied. Encroaching a little on 1903 work, it may be added that a long series of failures occurred from the use of abundant specimens off Goat LXLIV. on the first and second days of its fever. Specimens dropped three days later proved pathogenic in every case. There is a possibility that the fever present when the early ticks dropped was not due to heartwater. A very large number of larval ticks of the Bont species and of *Rhipicephalus capensis* were on the animal, and we now recognise that fever temperatures may result from such excessive infestation. However, the rise occurred at the expected time for heartwater, and the course of the full fever was like that of the disease. Another failure occurred with the use of ticks taken from the dead body of a goat that succumbed to infection brought on by inoculation. The ticks were five months old when used and nearly dead from having been kept too dry. Six ticks bit, and one at least fed to engorgement. Another goat infested with ticks of the same lot became infected and died; eight of the ticks attached to this animal, but only two became engorged.

G. INFECTION DERIVED IN THE LARVAL FEEDING MAY FAIL TO PERSIST TO THE ADULT FEEDING.—Under D and E series of 1901, it was shown that ticks which became pathogenic by feeding on a sick animal when larvæ might infect animals during their adult feeding regardless of their nymphal feeding having been taken on healthy animals; in other words it was shown that no renewal of the infection may be necessary to keep the tick pathogenic over a feeding stage. At the same time, however, the deduction that the capacity to infect was often lost with the intermediate feeding was drawn from the experiments. Experience during 1902 affirmed these conclusions.

Goat No. LXXXII., an Angora cross, after having served as a control for two months, was infested August 12th with male Bonts off Oxen 1 and 2. About twenty attached. Females were applied August 25th and fourteen were recovered after engorgement. These very ticks had given the oxen heartwater, and hence as nymphs had certainly been pathogenic ; but as adults they failed to affect LXXXII.

On October 3rd, four females, which as nymphs had fed on salted goat LXV., were applied, and these all attached. These ticks were of a lot proved pathogenic as nymphs by a number of fatal infections, but LXXXII's temperature was not moved by them.

On November 14th, males, which as nymphs fed on the horse used in E were applied. Four attached. On November 21st, females of the same lot were added, and of these six took hold. Fever appeared December 9th, eighteen days after the females were applied, and death occurred December 13th from typical heartwater.

The infection was doubtless due to the female ticks last applied, though there was just as much reason to expect fever from any of the earlier applied specimens. The proportion of ticks in which the infection persists over a feeding stage may therefore be small.

H. INFECTION TRANSMITTED TO GOATS AFTER IMMERSING THEM IN COOPER'S DIP.—The idea was advanced during the year that the use of Cooper's powder for dipping sheep stopped heartwater. The tests which follow tend to refute the view. The animals employed were immersed a full minute by the watch in a dipping mixture prepared in exact accordance with the directions given on the packet.

1. Goat No. LXXXV., Angora cross, received November 24th. Infested leg November 28th, four hours after dipping the animal, with thirteen Bont nymphs off sick Goat LV., March 16th. Notwithstanding their long fast of eight and a half months, the ticks bit well and nine fed to repletion. Fever appeared December 15th and death from heartwater followed on the 20th.
2. Goat No. LXXXVI., Angora cross, received November 24th. Infested leg November 29th, twenty-four hours after dipping the animal, with sixteen Bont males off Ox 2, about April 22nd. Though they had not fed for over seven months, fifteen of the ticks attached at once and remained. As many females were applied December 6th and all attached. As generally happens on the leg of a goat, however, the females swelled out very slowly ; none came off until the 24th day. The ticks were thought to be pathogenic as the ox was in fever when they last fed, but no fever followed (see F, last paragraph). Four Bont nymphs off the ox on the same date as the adults were applied January 22nd. Three fed. Fever appeared February 3rd and terminated fatally on the 6th.
3. Goat No. LXXXVII., Angora cross, received November 24th. Infested leg December 2nd, four days after dipping the animal, with about twenty Bont nymphs off Ox 2 about April 22nd. Fourteen of the ticks succeeded in feeding to repletion despite their famished condition. Fever appeared December 18th and death followed on the 20th.
4. Goat No. LXXXII. was under the E test when dipped November 28th. Four male and six female Bonts were then on a leg. These ticks all appeared lifeless the day after the dipping but two days later it was obvious that only two males and one female had actually succumbed. Fever appeared December 9th and terminated fatally. The dipping did not check the infection.

5. Goat No. LXIX.. Angora cross, received May 10th. Used as control and in negative tests before being dipped with the other goats on November 28th. Infested December 31st, that is about five weeks after the dipping, with thirteen Bont nymphs, last fed on Ox 2 and dropped by that animal April 22nd, over eight months previously. Five specimens fed to repletion on the goat. Fever appeared January 14th and terminated fatally on the 17th.

Thus the dipping failed to check infection already transmitted (No. 4), and to prevent infection by ticks applied the same day, after four days, and after five weeks. The hair of the animals was quite yellow with the sulphur of the dip for several weeks. Some of the goats, those recently brought to the stables, were somewhat infested with *Rhipicephalus capensis* nymphs picked up on the veld. Many of these ticks were destroyed by the dipping. Others, which dropped apparently unharmed, were set aside in dishes to moult, and were all found to succumb, whilst ticks of the same kind caught from undipped animals moulted successfully.

I. THE PROGENY OF PATHOGENIC BONT TICKS APPEAR NON-INFECTIOUS.—This subject was discussed under M in the last report. Two more tests, both yielding negative results, were made during the past year.

1. Goat No. LVI., Angora cross. Used previously in a negative test. Infested February 7th, with large number of larvæ from eggs laid by female Bonts off Sheep XLV. when in high heartwater fever October 12th—16th. 2,830 engorged larvæ recovered but the temperature not raised. Proved susceptible in July by inoculation from Calf V. in D series.
2. Goat No. LXXXIX., Angora cross, procured locally about December 1st. Infested December 22nd with Bont larvæ from eggs laid by females from Goat LVIII. at death from heartwater. About 2,100 larvæ recovered after feeding, but the temperature was not raised. Killed January 18th owing to injury from which recovery seemed impossible.

J. RECOVERED ANIMALS LOSE CAPACITY TO INFECT TICKS SOON AFTER CESSATION OF FEVER.—That Bont ticks from recently recovered animals may give the disease was discussed under C last year. In case 1 of that series fatal fever was induced in Goat L. by ticks taken from Goat XLIV. seventeen days after the fever had subsided. This case was doubtless good. In case 2, what was considered a mild attack of heartwater fever was induced in Goat LI. by ticks taken from Goat XL. fourteen days after the lapse of fever. There is now reason to believe that the fever in this second case

was not due to heartwater. Bont ticks which fell during the fever period were subsequently tested, and failed to produce any reaction. The fever, as was recorded in the last report, ran an unusually low course, during which there was no lack of appetite or external symptom of disease. The animal at the time was infested with a large number of Blue ticks, the object being to secure engorged females at the height of the heartwater fever that was expected. It is now thought that the long low course of fever which came was due to the presence of these Blue ticks (see N below). If this surmise is correct, Goat XL. lost the capacity to infect ticks within fourteen days after the fever. Over 400 were used on the test animal, and about 275 were recovered —so any failure to infect could not have come from a lack of sufficient ticks.

Goat XLIV. was capable of infecting ticks that fell from it up to the seventeenth day, but ticks which fell from it, December 2nd, between five and six weeks from the cessation of its fever, proved innocuous when applied to Goat LIII. That this animal was susceptible was proved by its infection in E tests at a later date. Veterinary Surgeon Spreull has shown (Cape *Agricultural Journal*, May 22, 1902, p. 633) that blood becomes less and less infectious after the cessation of the fever, and that no reaction may result after about the twentieth day.

K. Recovered Animals may or may not re-act to Infection.—It is important to ascertain whether or not recovered, that is salted, animals take any part in maintaining the infection on the veld. The following tests show that recovered animals may or may not give a febrile reaction in attempts to infect them.

1. Goat No. LXV., Angora ewe, two-tooth, received at Cape Town April 23rd from Veterinary Surgeon Spreull, Somerset East, who wrote that it "had a long double febrile reaction without sickness to a subcutaneous injection of modified heartwater blood, gave a slight reaction to a 2·5 c.c. intraveneous test (virulent blood), and resisted 3 c.c. injected in the same way on December 5th, 1901." Thus the animal seemed well "salted." It was infested April 23rd with about thirty Bont nymphs off heartwater goat LV. at death. Twenty-four recovered after feeding. A distinct febrile reaction occurred May 14th to 21st (Table III. appendix), but no other sympton of disease was observed.

Inoculated intravenously July 29th with 5 c.c. blood from heartwater goat LVI., but without producing any disturbance of the temperature. Inoculated intravenously January 21st with 50 to 55 c.c. blood from a heartwater goat, and a distinct febrile reaction was produced from February 2nd to 8th. No other sign of disease was observed.

2. Goat LXVI., old Angora ewe, received with LXV. from Mr. Spreull, who wrote that it "was very sick and fevered twelve days, and had proved resistant to 10 c.c. virulent blood, intravenously injected January 28th." This well salted animal, like LXV., was subjected to infestation by thirty Bont nymphs last off LV. Sixteen were recovered. However no trace of a febrile reaction resulted. The animal was kill:d after ten weeks because it suffered from a paralytic trouble.
3. Sheep No. LXVIII., merino wether which recovered from inoculation of virulent blood out of Ox 2 in No. 4 of series D tests. Was ill in early May. Infested June 14th with about thirty-five Bont nymphs from LV. Twenty recovered. Subsequent temperature too variable to permit of detection of any reaction. (Nearly all the merinos experimented with at the stables have had extremely variable and often seemingly abnormally high temperatures, even when in apparently good health).

Inoculated intravenously July 29th with 5 c.c. blood from sick LVI. Abnormally high temperature followed from August 15th to 21st, and this may have been due to the inoculation; no outward symptom of illness was manifested.

Inoculated intravenously December 16th with 60 c.c. blood from sick LXXXV. (H series). What may have been a fever reaction, occurred January 2nd to 7th. Blood was drawn and a goat inoculated January 6th. This animal (LXL.) died on the eleventh day without having had fever, and unfortunately the *post mortem* examination evidence was inconclusive in regard to the cause of death.

Inoculated intravenously January 17th with 150-160 c.c. from dying LXIX. (H series). Again a fever period followed, the temperature from January 24th to 28th being distinctly abnormal, but no outward sympton of illness was manifested. Blood was drawn and a goat inoculated January 28th. No fever occurred in the new goat (LXLII.) but on the seventeenth day it was found down and unable to keep its feet when raised. It died during the day, but through an oversight was disposed of without opening. At the time it was thought that the animal had sustained internal injuries from slipping on the smooth cement floor.

The temperature records of these three salted animals during the critical period subsequent to their exposure to fresh infection appears in Table III. of the Appendix. The only conclusion which we can draw at present is that salted animals may possess a very high degree of resistance to fresh infections, either from ticks or injected blood.

L. Bont Ticks dropped by Recovered Animals during Febrile Reactions to subsequent Infection may or may not be Pathogenic.—This subject is very closely related to the last, but is separated to avoid complexity. Veterinary Surgeon Spruell has shown (see *Cape Agricultural Journal* for May, 1902, p. 633) that a goat may give a strong febrile reaction, to inoculation with blood of attenuated virulence, without acquiring

sufficient immunity to resist infection from properly virulent blood later. He has also found, by tests with ticks received from this office, that pathogenic Bont nymphs may fatally re-infect such a "reacter." Recovered goats that succumb to subsequent infection unquestionably infect ticks that feed on them during their second reaction, and so far as keeping up the infection of a piece of veld is concerned, they are equivalent to susceptible animals. But it is of importance to learn whether or not recovered animals that give only scarcely noticeable reactions to subsequent infections make ticks pathogenic during the fever period. If they do not infect the ticks, heartwater infection presumably dies off quickly from veld pastured only with recovered animals. Whereas if they do infect ticks, the infection may persist on the veld a long time, perhaps several seasons, after the last observed case of the disease; and thus the pasturage remain dangerous for susceptible animals. Also, for aught we now know, it may be that ticks dropped by recovered animals suffering a mild attack usually transmit only a mild strain of fever to susceptible animals, which strain must pass through a series of susceptible animals before it becomes fatally virulent. Perhaps a succession of mild attacks may fortify an animal against a severe one. In our experiment stables it is highly exceptional for a goat to survive an attack, whilst on long infected heartwater veld the mortality is not nearly so high, probably not being over sixty per cent. at the most. The pathogenic ticks used in the stables are recovered from dying goats, whilst those acquired on the veld may come from mild or fatal cases; and this difference may be accountable for the greater mortality at the stables.

Tests of ticks from recovered animals during mild after attacks of the disease have long been projected, but no fit subject on which to rear ticks has recovered at the stables for over two years. For want of better animals initial attempts were made with animals LXV., LXVI., and LXVIII. discussed under K. No. LXVIII., the merino wether, proved an impracticable

subject. No. LXVI. failed to give any reaction. But No. LXV. dropped a great abundance of specimens during its fever period, May 14th to 21st. These ticks were tested as follows:—

1. Goat No. LXIX., Angora cross kapater, from Stellenbosch, about May 10th. Infested August 15th, with about seventy-five Bont nymphs from LXV., May 12th to 15th. Fifty-one recovered. No reaction

   Infested September 18th heavily with Bont nymphs off LXV., May 16th and 17th. One hundred five recovered. No reaction.

   Infested October 11th with more of same lot. Two hundred seventy-five recovered. No reaction. Subsequently proved susceptible in H series.

2. Goat No. LXX., Angora cross ewe, from Stellenbosch, about May 10th Infested August 8th with about fifty Bont nymphs off LXV., May 17th to 20th. Twenty-six recovered. No reaction. Animal alive at time of writing.

The recovered animal in this case certainly failed to infect the ticks, despite its having been in fever when it dropped them. In early February the animal again gave a fever reaction to heartwater infection as recorded under K, this time from the unnatural means of inoculated blood, and that in large quantity, and again a good catch of ticks was secured during the fever.

3. Goat No. LXLV., Angora cross kapater, from Faure, in January. Infested March 10th with Bont nymphs off LXV., February 5th to 8th. Thirty-seven recovered. Fever appeared March 31st and terminated fatally April 2nd. Lesions typical.

4. Goat No. LXLVI., Angora cross kapater, from Faure, in January. Infested March 17th with Bont nymphs off LXV., February 5th to 8th. Two hundred ten recovered. Fever April 5th, and death April 8th. Lesions typical.

Here we have results entirely at variance with those before secured, both animals contracting quickly fatal fever. At a future date another attempt will be made to infect LXV. in order to again repeat the experiment; and when the opportunity presents itself tests will be made with ticks from other recovered animals.

M. Blue Ticks are non-pathogenic.—The incapacity of the Blue Tick to transmit heartwater was indicated by three tests discussed under R in last year's report. The following two cases give further support to the conclusion then reached that the Blue Tick is non-pathogenic in regard to this disease.

1. Goat No. LIII., Angora cross ewe, from Stellenbosch, in October, 1901. Infested March 2nd with larval progeny of Blue ticks off Goat LVII., January 14th and 15th when at height of unaffirmed, non-fatal fever following application of pathogenic Bont nymphs. Somewhat abnormally high temperatures produced March 9th to 16th.

   Infested again March 18th with larval ticks of same history. Abnormally high temperatures produced March 29th to April 5th. Bled April 8th and 8 c.c. blood inoculated intravenously into a clean goat; no disturbance of temperature resulted.

2. Goat No. LXX., an Angora cross ewe, long on hand. Infested November 22nd with progeny of Blue ticks off Ox 3, July 16th, just after fever. Not many ticks matured. No reaction.

N. BLUE TICKS MAY CAUSE A NON-INOCULABLE FEVER.—Ten times during the year, for one purpose or another, large numbers of the Blue Tick have been reared on goats, and in every case the temperatures of the infected animals have been abnormally high during some part of the feeding period. In a few cases the high temperatures simulated a mild heartwater fever; but usually there was no "curve," high temperatures and normal temperatures following one another in a most irregular manner. In nearly all, the period of irregular temperature began about the tenth day, but in one it came on as early as the sixth, and in two was delayed until the seventeenth and eighteenth respectively; it generally continued until most of the ticks were off. Two goats were bled when the temperature was thus abnormal, and other goats inoculated but in neither case was the fever re-produced. For some time I was puzzled to account for the erratic temperatures and feared that mild heartwater was present, but I am now persuaded that the irritation produced by the ticks was responsible. In several of the cases it is noted on the "charts" of the animals that the goats exhibited great irritation from the ticks by their behaviour. Rather curiously the longer-beaked Bont Tick appears to give much less annoyance to the animals than the Blue; but in studying the charts of numerous animals to which large numbers of the Bont have been applied, somewhat abnormal temperature records are now noticed in a few cases which may perhaps be attributable to irritation.

TABLE I.

Calf Infections by Ticks from Goats.

Number of Days.	Ox No. 1.			Ox No. 2.			Ox No. 3.		
	a.m.	p.m.	Notes.	a.m.	p.m.	Notes.	a.m.	p.m.	Notes.
	101·0	102·0		102·2	103·6		101·0	102·0	
	102·0	103·0		101·6	102·8		101·6	100·8	
	102·2	103·8		102·4	104·0		102·0	102·0	
	102·0	103·0		103·0	102·4		100·6	102·0	
	101·4	102·4		101·4	102·0		101·4	102·2	
	101·2	104·4	Ticks applied.	100·4	104·0	Ticks applied.	102·0	101·6	Ticks applied.
1	101·2	103·0		100·2	103·0		102·0	102·0	
2	101·0	103·4		102·0	103·2		101·0	101·4	
3	101·2	104·0		101·0	103·0		100·6		
4	101·0	104·0		102·0	104·0		101·8	101·6	
5	101·2	103·6		102·6	104·0		101·0	103·0	
6	102·0	102·0		102·0	102·0		101·0	102·6	
7	101·0	103·0		101·6	103·0		101·6	101·0	
8	100·6	102·4		102·0	102·4		101·2	102·4	
9	100·6	100·6		101·0	99·4		101·8	102·4	
10	100·8	102·6		102·4	103·2		100·2	101·8	
11	102·0	102·6		101·6	103·0		101·4	102·2	
12	101·0	103·2		101·2	103·4		102·4	102·0	
13	102·4	103·8		101·6	104·0		102·0	103·4	
14	102·0	101·4		102·4	102·0		102·2	102·6	
15	102·0	103·4		101·4	103·2		101·4	102·0	
16	101·2	103·4		101·6	102·4		100·4	102·6	
17	101·6	104·0		101·0	103·2		100·6	103·4	
18	102·0	104·0		101·6	103·4		100·0	103·4	
19	102·4	104·8		102·0	105·0		102·2	103·0	
20	*103·2*	*104·4*		*104·0*	*105·0*		101·6	102·0	
21	*103·4*	*105·0*	Goats inoculated	*104·8*	*106·2*		101·4	102·6	
22	*105·4*	*106·6*		*104·4*	*105·6*		*103·0*	102·2	
23	*105·2*	*104·4*		*105·2*	*105·2*	Appetite small.	*103·0*	*103·0*	
24	*102·6*	*104·6*	Succumbed.	*105·0*	*105·6*		*104·0*	*104·0*	
25				*104·0*	*105·0*	Sheep inoculated	*103·0*	102·2	
26				*103·2*	*103·8*		102·0	103·4	
27				103·2	103·0		102·2	*104·0*	
28				103·0	103·6	Again eating well	*104·0*	*105·2*	
29				103·0	102·0		*103·6*	*105·0*	
30				103·4	102·6		*105·0*	*105·4*	Appetite small.
31				103·0	103·6		*104·0*	*103·6*	Acts ill.
32				102·6	102·2		101·0	103·0	
33				102·0	103·6		101·2	103 2	Seems better.
34				101·0	103·2		103·2	101·4	Goat inoculated.
35				102·0	101·6		101·0	103·2	

Note.—Ox 3 was infested much later in the season than Nos. 1 and 2, and owing to the shed then being cooler in the afternoon, the p.m. temperatures from this animal are relatively low.

TABLE II.

Calf Infections by Ticks from Calves.

Number of Days.	Ox No. 3.			Ox No. 4.			Days from second lot of ticks.
	a.m.	p.m.	Notes.	a.m.	p.m.	Notes.	
	102·6	103·0					
	102·6	103·0					
	104·0	103·0					
	103·0	104·0					
	102·2	104·2					
1	103·0	105·0	Ticks applied.		101·4	Ticks applied.	
2	104·0	102·6		102·0	101·8		
3	102·0	102·2		101·6			
4	102·0	103·2		101·6	101·6		
5	103·0	102·2		101·8	102·0		
6	102·2	103·0		101·0	101·6		
7	102·0	101·6		101·2	103·0		
8	102·0	103·0		101·6	103·0		
9	103·0	103·6		102·0	102·4		
10	103·0	103·6		101·6	104·0		
11	103·0			101·2	103·2	Ticks applied.	
12	101·2	102·0		101·4	103·0		1
13	103·0	103·2		102·0	102·2		2
14	103·0	104·4		102·0	103·0		3
15	104·4	103·2		101·6	103·0		4
16	103·0	103·4		101·2	101·8		5
17	102·6	105·0		102·0	102·6		6
18	102·6	105·4		101·2	102·6		7
19	102·2	104·4		101·0	103·0		8
20	102·4	104·4		101·4	102·0		9
21	102·4	103·2		101·0	102·2		10
22	101·6	104·0		101·0	102·0		11
23	103·0	104·4		102·0	102·6		12
24	102·0	*106·0*		101·6	102·8		13
25	*105·0*	*106·2*		102·0	102·4		14
26	*105·0*	*105·0*		101·4	103·0		15
27	*104·2*	*105·4*		101·0	103·0		16
28	*104·0*	*105·0*	Falling off in flesh.	101·2	101·2		17
29	*103·6*	*104·4*		102·2	102·0		18
30	*104·4*	*105·6*		101·4	102·2		19
31	*104·0*	*106·0*		102·4	103·0		20
32	*104·2*	*105·0*	Very weak on legs.	101·0			21
33	*103·6*	*105·2*	Goat inoculated.	102·2	103·0		22
34	*104·0*	*104·0*		*102·6*	*103·6*		23
35	102·0	103·6		*103·6*	*104·0*		24
36	102·0	103·0		*103·2*	*104·6*		25
37	101·0	103·0	Feeding better.	*104·0*	*104·6*		26
38	100·4	104·0		*103·8*	*105·4*	Feeding little.	27
39	101·0	101·6		*103·4*	*104·8*		28
40	101·4	102·6	Condition much improved	*102·8*	*105·4*	Goat inoculated.	29
				105·4	*105·6*		30
				104·0	*104·6*		31
				104·0	*104·4*		32
				103·8	*105·0*	Purging.	33
				101·0	102·4	Down and very weak.	34
				99·4	102·0		35
				98·0	100·4		36
				97·0		Destroyed.	37

TABLE III.

Reactions of Recovered Heartwater Animals to Fresh Infection.

GOAT LXV.										GOAT LXVI.		
Date.	a.m.	p.m.	Date.	a.m.	p.m.	Date.	a.m.	p.m.		Date.	a.m.	p.m.
April 23	Infested with pathogenic ticks.		July 29	Inoculated with 5 c.c. virulent blood.		Jan. 21	Inoculated with 5 c.c. virulent blood.			April 23	Infested with pathogenic ticks.	
24			30	102·0	102·6	22				24		
25			31	101·4	103·0	23				25		
26			Aug. 1	102·0	102·8	24				26		
27	100·8	102·2	2	102·0	102·4	25	101·4	102·6		27	100·6	102·4
28	101·6	101·4	3	102·0	101·2	26	101·8	102·4		28	101·2	102·4
29	101·0	103·0	4	101·0	103·0	27	101·2	102·0		29	101·2	103·0
30	101·2	102·4	5	101·6	102·2	28	101·2	103·0		30	101·2	102·8
May 1	101·2	103·2	6	102·0	102·0	29	101·6	103·0		May 1	101·0	102·2
2	100·6	102·0	7	101·0	102·8	30	101·0	103·2		2	100·6	104·4
3	100·0	102·2	8	101·4	102·0	31	101·2	104·0		3	101·0	103·4
4	100·4	101·0	9	101·4	102·2	Feb. 1	101·8	104·0		4	101·0	103·4
5	101·0	102·2	10	102·0	103·0	2	*102·2*	*105·0*		5	101·0	103·0
6	100·4	102·0	11	101·4	102·4	3	*103·0*	*105·2*		6	100·4	103·0
7	101·4	104·2	12	101·2	104·2	4	*103·0*	*104·0*		7	101·4	103·4
8	101·0	103·0	13	101·4	102·0	5	*103·0*	*104·0*		8	101·0	103·2
9	100·0	102·4	14	101·2	101·6	6	*102·2*	*103·6*		9	100·0	103·6
10	100·2	103·0	15	101·2	102·6	7	*102·0*	*104·6*		10	101·2	102·2
11	100·6	103·0	16	101·4	102·0	8	*102·2*	*104·0*		11	101·2	102·6
12	101·0	103·0	17	101·0	101·4	9	100·0	104·0		12	100·6	103·0
13	100·0	102·2	18	101·0	102·0	10	101·2	102·0		13	100·4	103·0
14	*102·4*	*103·8*	19	101·6	103·0	11	100·6	104·0		14	100·6	103·4
15	*103·2*	*105·4*	20	101·8	103·0	12	100·6	103·0		15	102·4	103·4
16	*103·0*	*104·4*	21		103·4	13	102·4	103·4		16	101·0	101·4
17	*103·2*	*103·2*	22	102·0	102·8	14	102·0	103·0		17	100·4	102·0
18	*102·0*	*104·2*	23	102·0	102·6					18	101·0	102·6
19	*104·0*	*103·4*	24	102·2						19	101·0	103·0
20	*102·6*	*104·0*	25	102·0	101·6					20	101·6	103·6
21	*102·4*	*103·4*	26	102·0	102·0					21	101·6	102·6
22	102·0	102·4	27	102·2	103·0					22	101·2	103·0
23	101·6	102·0	28	102·0	103·0					23	101·2	103·0
24	102·0	103·0	29	102·0	103·8					24	102·0	102·8
25	101·2	103·2	30	102·6	104·0					25	101·0	102·4
26	101·0	102·4	31	102·4	104·0					26	101·0	103·0
Bont Ticks dropped during fever failed to reproduce the disease.			Failed to react whilst control animal sickened and died.			Bont Ticks dropped during fever reproduced the disease.				Failed to react.		

TABLE III.

Reactions of Recovered Heartwater Animals to Fresh Infection—*continued.*

SHEEP LXVIII.

Date.	a.m.	p.m.	Date.	a.m.	p.m.	Date.	a.m.	p.m.	Date.	a.m.	p.m.
June 14	Infested with pathogenic ticks.		July 29	Inoculated with 5 c.c. virulent blood.		Dec. 16	Inoculated with 60 c.c. virulent blood.		Jan. 17	Inoculated with 150 c.c. virulent blood.	
15			30			17			18		
16			31	102·0	104·4	18	102·4	102·2	19	102·0	103·8
17			Aug. 1	102·0	100·0	19	102·0	103·4	20	102·2	103·0
18	102·0	102·0	2	102·0	103·2	20	103·0		21	102·0	103·4
19	103·4	102·2	3	101·6	101·0	21	102·0	106·0	22	102·0	104·0
20	102·6	104·0	4	101·0	104·0	22	103·8	103·0	23	103·4	102·6
21	103·0	102·6	5	102·6	102·2	23	102·6	103·0	24	101·4	101·2
22	103·2	104·0	6	102·0	103·0	24	103·2	102·8	25	*103·4*	*103·2*
23	102·6	104·4	7	102·0	102·8	25	102·6	102·6	26	*103·6*	*104·0*
24	102·4	103·8	8	101·6	102·4	26	101·0	103·2	27	*104·0*	*105·0*
25	102·2	103·8	9	101·6	102·4	27	101·0	102·6	28	*104·6*	*104·6*
26	103·0	104·4	10	102·0	104·0	28	101·6	103·2	29	102·2	103·6
27	102·6	100·4	11	102·4	103·0	29	102·2	103·8	30	101·0	103·2
28	101·6	103·2	12	101·2	102·6	30	102·0	102·4	31	102·0	104·0
29	102·8	103·0	13	101·6	103·0	31	101·4	102·2	Feb. 1	100·8	103·4
30	102·0	104·4	14	102·0	103·0	Jan. 1	102·0	103·0	2	101·6	104·6
July 1	102·8		15	*102·4*	*104·0*	2	*102·8*	*104·0*	3	102·0	104·6
2	102·4	104·2	16	*102·6*	*106·0*	3	*102·2*	*104·0*	4	101·2	103·0
3	102·6	103·8	17	*103·6*	*104·0*	4	*103·4*	*105·0*	5	100·0	103·0
4	102·2	103·0	18	*104·0*	*104·8*	5	*104·2*	*104·8*	6	100·8	102·2
5	103·0	103·4	19	*104·0*	*104·0*	6	*104·0*	*106·0*	7	101·6	104·6
6	103·6	104·0	20	*103·2*	*103·8*	7	*102·4*	*103·0*	8	102·0	103·6
7	103·0	103·0	21	*102·4*	*104·6*	8	*102·0*	*105·0*	9	101·0	103·4
8	102·0	103·6	22	101·6	103·6	9	102·0	102·6	10	101·0	103·2
Uncertain that any reaction occurred.			Tardy reaction for infection by blood.			Again a tardy reaction			Slight reaction at proper time.		

CAPE OF GOOD HOPE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

YEAR 1903.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

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Cape Town, 15th January, 1904.

THE HONOURABLE THE SECRETARY FOR AGRICULTURE.

SIR,—I have the honour to present herewith my report for the year 1903.

CHAS. P. LOUNSBURY, B.Sc., F.E.S.,
Government Entomologist.

TABLE OF CONTENTS.

	PAGE
Letter of Submittal.	
General Statement	1
Contributions to *Agricultural Journal*	2
Reprints for Distribution.	
Plant Import Regulations;	2
New Schedule in force.	
Supervision of Examiners.	
Chief Inspector appointed.	
Inspections by Entomologist.	
Parcel Post Consignments.	
Confiscations.	
Codling Moth by Post.	
Nursery Legislation	4
Bill introduced but not acted upon.	
Projected introduction next Session.	
Similar Bill framed in Transvaal.	
Need in other Colonies.	
Eastern Province Entomologist.	5
Appointment of Officer promised.	
Duties begun by Assistant Entomologist.	
Present Staff of Entomological Branch.	
More Assistance urgently required.	
Need for an Agricultural Experiment Station	6
Value of a Station in Entomological Work.	
Animal Diseases Experiment Station	7
REPORT OF ASSISTANT ENTOMOLOGIST AT GRAHAMSTOWN	9

SPECIAL REPORTS.

TICKS AND AFRICAN COAST FEVER	11
Slow Progress of Investigation explained.	
Trips to Transvaal and Rhodesia for Material.	
Tests conducted.	
Rhipicephalus appendiculatus concerned.	
Cases of the Disease produced by Tick infestation	12
TICKS AND HEARTWATER	15
Failures in Use of Ticks presumed Pathogenic.	
A. Infection is transmitted by Bont Tick soon after its Attachment	16
B. Cattle are subject to Heartwater	17
The Disease much milder in Cattle than in Merinos or Goats.	
C. Persian Sheep are liable to Heartwater	19
Non-fatal Disease only produced.	
D. Rhipicephalus appendiculatus or Brown Tick not a Carrier of Heartwater	20

PAGE.

TICKS AND MALIGNANT JAUNDICE 22
Reasons for studying its Transmission.

Nature of the Disease 22
Relation to Redwater.
Symptoms and Course.
Dog the only Animal known to be affected.

Occurrence of the Disease 24
How long known in Colony.
Probably present a Century ago.
Disappearance from Localities.
Variations in Virulence.
Treatments in vogue.

The Transmitting Tick 27
Habits of Hæmaphysalis leachi. ... ...
Probability of other Ticks transmitting the Disease.
Other species found on Dogs.

When and how the Tick becomes infectious 30
Adult Ticks only transmit Infection.
Both Sick and Recovered Dogs a Source of Infection.
Many Ticks from infectious Sources quite innocuous.
Seasons when the Disease prevalent.
Susceptibility of young Dogs.

Experiments 34
Co-operation with Veterinary Department.
Origin of Animals used.

A. Infection transmitted by Adult Progeny of the Dog Tick when from a sick or recovered Dog 35
B. Failures to infect by Adult Progeny of Ticks from sick and recovered Animals 38
C. Adult Progeny of Dog Tick fed during incubation Period of Disease non-pathogenic 40
D. Nymphal and Adult Dog Ticks fed in previous Stage on sick or recovered Dogs non-pathogenic 40
E. Adult Dog Ticks removed from Dogs dying of the Fever may or may not be pathogenic 41
F. Jackal naturally immune to the Disease 42
G. Tests with other kinds of Ticks, and Fleas 42

APPENDIX. PLANT IMPORT REGULATIONS PROCLAMATION 45

Illustrations.

Plate I. Graphic Temperature Charts of Cattle infected with African Coast Fever by Means of the Brown Tick.

Plate II. Graphic Temperature Charts of Cattle infected with Heartwater by Means of the Bont Tick.

Plate III. Graphic Temperature Charts of Persian Sheep infected with Heartwater by Means of the Bont Tick.

Plates IV., V. and VI. Graphic Temperature Charts of Dogs infected with Malignant Jaundice by Means of the Dog Tick.

Plate VII. Animal Diseases Experiment Station Building at Rosebank.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Year 1903.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1904.

Aside from the routine duties of attention to the entomological correspondence of the Department, the preparation of special reports on matters appertaining to insects, visits amongst farmers to advise them relative to insects troubling them at the time, contributions to the Departmental periodical publication, and the inspection of plant imports arriving at the port of Cape Town, the chief work accomplished during the year was in investigating the relations of ticks to African coast fever in cattle, heartwater in cattle, sheep and goats, and malignant jaundice in dogs. Detailed reports to show the progress made in these special subjects are appended; likewise a separate report from the Assistant Entomologist covering his work for the last four months of the year, during which period he has been detached from the main office.

CONTRIBUTIONS TO THE "AGRICULTURAL JOURNAL."—The signed contributions to the *Agricultural Journal* were as follows:—

TITLE.	Form.	Issue.	Pages.
			Vol. xxii.
Dust Sprayers	Article	January	78-80
Fruit Moths	Notes	,,	81-84
Locust Poisons	,,	,,	84-85
Troublesome Beetles (Mylabris)	Letter	,,	95
Poisonous Insects (Intonjane)	,,	,,	98
Fowl Lice and Ticks	,,	April	472
Melon Pests	,,	,,	473
Potato Tuber Moth	Notes	June	717-719
			Vol. xxiii.
Dust Spray	Letter	July	91
Merchantable Insect Pest	,,	,,	92
Weevils in Grain	Notes	,,	94-96
Bryobia Mite	Article	August	179-184
Fruit-eating Wasps	Letter	,,	208-209
Fowl Tick	Article	September	261-273
Legislation to exclude Plant Pests ...	,,	October	399-404
Gall Worms in Roots of Plants	Notes	,,	468-469
Fowl Tick: Habits of Larvæ	Letter	November	594
New Oak Tree Pest: Phylloxera	Article	December	655-658

Reprints of the notes and articles "Locust Poisons," "Potato Tuber Moth." "Bryobia Mite," "Fowl Tick," "Legislation to exclude Plant Pests," and "New Oak Tree Pest" were secured, and copies may be obtained by interested parties on application to the office.

PLANT IMPORT REGULATIONS.—Long urged amendments to the "plant import regulations" were approved in March. The schedule which then came into force appears as an appendix to this report, whilst a full explanation of the various sections, for the guidance of intending importers, was published under the title "Legislation to exclude Plant Pests" in the October issue of the *Agricultural Journal*. Only a very limited number of fruit trees (and nut trees) may now be introduced, and these only by special permission from the Minister for Agriculture. A proposal by the Conservator of Forests to extend the restriction to forest and shade trees is now under consideration.

Until within a few months there was practically no direct supervision over the Examining Officers charged

with enforcing the regulations at the different ports; but in September, the Minister approved of my recommendation (first made in my 1898 annual report, page 9) that a "chief inspector" be appointed, and as the officer of the Department most interested the post was assigned to me in connection with my other duties. The step costs the Department nothing, and, I believe, adds greatly to the efficiency of the regulations.

The Examining Officers at East London, Mossel Bay, and Cape Town are Customs officials, and the one at Port Elizabeth is the city superintendent of parks. These men do their work faithfully and as well as can be expected of officers without entomological training. It is at present out of the question to have qualified entomologists as inspectors, because there is not enough work at any one of the ports to keep such a man profitably employed, and the appointee, whoever he is, must keep himself within easy reach of the searcher's office.

For several years, I have had the self-assumed task of examining, or of having my assistant examine, all plant and tree imports landed in Cape Town. The number of such consignments to this port is greatly in excess of that to the other ports combined. The work of inspecting is sometimes a severe drain upon our time; and during the past year it entailed between one hundred and one hundred and twenty-five trips to the searcher's office. The inspection of fruits, potatoes, and onions, and the superintendence of fumigating operations is left to the paid examining officer. Consignments of plants and trees arriving at Port Elizabeth for Graham's Town nurseries are now sent unopened to their destinations; and are there inspected by the Assistant Entomologist, and fumigated in chambers on the nursery grounds. By arrangement with the Postmaster-General, all parcels containing articles affected by the regulations, which arrive from over sea, are stopped in transit and sent to my office for examination of the contents. Three hundred and sixty-three such parcels were thus dealt with during the past year.

Confiscations of plants and fruit under the regulations were few during the year, and were chiefly confined to Cape Town. Often, however, pest insects, generally

scales, were discovered in the course of examination, and were dealt with by fumigation of the infected articles with hydrocyanic acid gas. One large consignment of currant bushes from England was burned, owing to severe infestation by a species of *Pulvinaria*, and a small consignment of apple trees similarly disposed of because massed with healthy Oyster Shell Bark Louse (*Mytilaspis pomorum*). The presence of the latter insect also led to the destruction of a lot of apple scions that came by post. As an instance of how the codling moth may be disseminated it is worth mentioning that three times during the year this insect was found in apples that came through the post; in one case holes through the wrappings indicated that one or more of the larvæ had escaped from the parcel.

NURSERY LEGISLATION.—On my urgent recommendation the Minister for Agriculture introduced the long framed "Nurseries Inspection and Quarantine Bill" before the late session of Parliament; but the Bill failed to receive a second reading owing to the premature dissolution of the House. I shall endeavour to get it introduced next session. An article discussing the measure, and urging fruit growers to actively support it, will be published in the February issue of the *Agricultural Journal*.

The Transvaal Government Entomologist, an officer appointed during the year, in conjunction with the Horticulturist of his department of agriculture, has drafted a nursery bill for his colony, and has hopes of its being approved at the next session of the Legislative Council. Fruit growers in the other South African colonies are recommended to study these bills, and to urge their governments to consider them. It seems a great pity that pests should be allowed to accompany fruit trees into new orchards miles from where any fruit trees, except perhaps a few grown from seeds planted by missionaries and early pioneers, have ever grown before. Yet such is being done. Little more than a decade ago Bulawayo was a native kraal far beyond the outposts of civilisation. Now a fine collection of introduced scale pests can be made in its gardens and parks.

EASTERN PROVINCE ENTOMOLOGIST.—Early in the year the Minister for Agriculture yielded to persistent representations from Graham's Town public men that an entomologist should be located in the Eastern Province by promising that one should be there stationed as soon as funds could be secured from Parliament. I was instructed to plan accordingly, and schemed to place Mr. C. W. Mally, M.S., the Assistant Entomologist, at Graham's Town in September immediately after his return from four months' leave of absence, and to replace him at Cape Town by a qualified new assistant. Provision was made for a new man on the Estimates, but because of the dissolution of Parliament without the Estimates having been passed, the steps towards getting one have had to be abandoned. Mr. Mally's leave was timed to have him back to begin his new duties at the opening of spring, the most seasonable time to start general entomological work, and he had already proceeded to Graham's Town when Parliament was dissolved. Accommodation for him had been found at the Albany Museum, and as all arrangements for his taking up work in the East had been made, it was deemed inadvisable to recall him. However, it will be necessary to have him return if funds for an "Eastern Province Entomologist" are not soon provided. Meanwhile the routine work of the Cape Town office has increased through changes in the "Plant Import Regulations," and, being short-handed, it has not been possible during the past year for me to get as much research work accomplished as during several previous years. The experimental tests of insecticides, which formed a valuable and prominent feature of the work in other years, had to be entirely dropped. There is now very urgent need for field work on the codling moth, which pest is this year doing tremendous damage in the south-western fruit districts; but unless provision for a qualified assistant is made soon, and a suitable man then found at once, little effective work on remedies for this pest will be possible during the next season without removing the Assistant Entomologist from Graham's Town.

The staff of the entomological branch of the Department now consists only of the Entomologist, one assistant, and an office boy at Cape Town, and the Assistant Entomologist at Graham's Town. Mr. Rupert W. Jack, the assistant at Cape Town, is an Englishman who was studying at Elsenberg Agricultural College when engaged. He had had no experience in economic entomology, or special training for entomological work; but a good general knowledge of insects obtained through reading and collecting has made him highly useful. His chief duties have been in connection with the details of the tick-disease investigation, work which has required attention to animals under experiment at all hours and every day in the year. Besides a qualified assistant to replace the Assistant Entomologist transferred to Graham's Town, a clerk, to attend to the correspondence and the keeping of the office records, is urgently required; and a helper of some sort must be provided the Assistant Entomologist if he is to remain detached from this office. As matters now are with him, there is no one to give attention to insects being reared at his office, or to attend to his correspondence when he is absent on field work.

If the vote for an entomologist in the Eastern Province is passed, the incumbent of the post will be styled "Eastern Province Entomologist." He will be under the general supervision of the Government Entomologist, but will be practically independent in planning and conducting investigations assigned to him. His position will be one of much responsibility, and I hope due recognition of this fact will be manifest in the remuneration granted him.

Need for an Agricultural Experiment Station.—Field observations and investigations constitute the phase of entomology most needed in a country like the Cape; and at the same time it is a phase of the subject to which it is most difficult to give adequate attention when a town office, particularly an office on the top floor of a building in the very heart of Cape Town, must serve as the base of operations. Headquarters in the vicinity of the administrative offices of the Depart-

ment are essential; but, to do justice to field work, there should be a sub-office on a general purpose farm, under departmental control, within easy reach. In other words, the establishment of an agricultural experiment station near Cape Town where crop pests could be studied and remedies tested, would greatly facilitate the practical work of the entomological branch of the Department. When the writer entered the Cape service eight years ago, there was already talk of starting a modern experiment farm; and he fancied that in the course of a year or two he would have an "insectary" on one, and be enjoying the facilities for practical work to which he had become accustomed in the United States. He isn't so sanguine of the near future now, but is just as firmly of the opinion that a modern agricultural experiment station is very much needed, and that the Cape shows itself far behind the times in not having one. Visitors from Australia and the United States express themselves surprised to find the Cape so remiss in this respect. And indeed we are very backward. While we have been sluggishly incubating the idea, the Japanese have awoke to the value of such institutions, and have established ten well-equipped government stations, each with a corps of specialists, aside from a small host of locally supported ones.

However, the matter of an experiment station is of much more vital concern to another officer of the Department, and I merely made mention of it in my report, to have it known that the usefulness of such an institution would extend to my field of work.

ANIMAL DISEASES EXPERIMENT STATION.—It is a genuine pleasure to note that suitable premises have been provided for the joint use of the veterinary and entomological branches of the Department in investigating the transmission of animal diseases of the country. Investigations of this character have been in progress at Cape Town for nearly four years, and the animals employed in the experiments stabled in temporary corrugated iron sheds and shelters on the site off Queen Victoria Street cleared for the projected Supreme Court building. Better accommodation has long been im-

perative. The site now built on was selected over eighteen months ago by Dr. Hutcheon and myself. It is on the portion of the Government-owned Erinville Estate adjoining the railway property on the east side of Rosebank Station. Rosebank may be reached from Cape Town in fifteen minutes by train. Six months passed before authority to build on the ground was granted. The sketch floor plans and general specifications were drawn by me, and after endorsement by the Chief Veterinary Surgeon were given to the Public Works Department in the closing days of 1902. In late March the ground was broken by the contractors, but, owing to numerous delays such as seem practically unavoidable in the erection of a Government building, however small, and however urgently required, the structure was not completed until December.

The accommodation is all in one building. The Public Works Department have made this a substantial brick structure, the neat appearance of which is shown in the accompanying illustration. There is a laboratory, *post mortem* room, forage room, small animals' room, two keeper's rooms (occupied by the entomological assistant), and seven stables, separated from one another by full height, unbroken brick partitions. The stables give stall or stanchion accommodation for twenty-four sheep and goats, ten cattle and nine horses or about twenty-five cattle, and about twenty-five dogs. The laboratory will be chiefly used by the Veterinary Bacteriologist, whose assistant occupies an annex on the grounds. The building is built about three sides of an open court, on to a roofed passage about which the various rooms open. The windows to the animals' rooms are high in the walls, and the fourth side of the court is formed by a high wall and plank gates; privacy is thus assured. As the work of the station increases, it is planned to have other rooms added to the wings. The present accommodation is already utilised to the full.

REPORT OF ASSISTANT ENTOMOLOGIST.

Graham's Town, 11th January, 1904.

Sir,—In accordance with your instructions, the study of the insect pests in the Eastern Province was begun at Graham's Town, September 7th, 1903. The room in the Albany Museum which was set aside for the use of the Entomologist has not been provided with the necessary equipment. In the meantime Dr. Schönland has kindly granted me the use of a table in the collection room, but I understand that even that will not be available much longer, for the room must be devoted entirely to the entomological collections of the Museum. Under such circumstances it is impossible to make the most of the time and opportunities available here for work in economic entomology.

Dr. S. Schönland, Director of the Albany Museum, has co-operated with me most heartily, and has done everything within his power to advance the interests of the entomological work here, and the Museum Committee, through their President, Dr. H. Becker, have always taken a keen interest in the work. To all of these gentlemen I wish to express my sincere appreciation of the many kindnesses and the encouragement which I have received from them. I wish also to express my obligation to the farmers and fruit growers who have taken an active interest in the work, and given me a free hand to make such observations and experiments as circumstances would permit. I have spared no effort to meet them, learn their needs, and render whatever assistance was within my power.

Although there is urgent demand for work on every hand, I have followed your expressed wish that the investigations be limited to the most urgent needs, with a view of doing thorough work rather than to attempt to cover the whole field and hence have to be content with superficial work. Under present circumstances there can be no doubt about the wisdom of that policy.

I have followed your suggestion that Mealie Insects, Fruit Moths, and Fruit Fly be given preference in the order named. Systematic field work is in progress on the lines named above, and also on miscellaneous insects so far as seems consistent with thoroughness. Important observations have been made and properly recorded, but since the work has been in progress such a short time it would be hazardous to attempt a statement in detail, and, therefore, I prefer to withhold the publication of the observations until they are more complete.

I have the honour to be,

Sir,

Your obedient servant,

C. W. MALLY,
Assistant Entomologist.

Government Entomologist,
Cape Town.

SPECIAL REPORTS.

TICKS AND SOUTH AFRICAN COAST FEVER.

In last year's report African coast fever was termed "Rhodesian cattle disease." The present name is the one recommended by Dr. Koch. Some attention has been given to the problem of elucidating the association of the disease with ticks throughout the whole year, but the progress of the investigation has been very seriously hampered by the difficulty of obtaining tick material for experimenting, and by the absence of any near source of infection. The disease is peculiar in that no means of transmitting it by inoculation has been discovered; therefore it has not been possible to keep it active at our experimental station, or to produce it at will by recovered blood or preserved virus, as is easy with heart-water, red water, malignant jaundice, horse-sickness, and other of our animal diseases that are known or presumed to be transmitted by tick or insect agency. The advantage of thus being able to communicate a disease is that an opportunity of feeding on sick animals ticks or other parasites under suspicion may at any time be made. The problem is then merely the making of a case of the disease when it is wanted, feeding the parasites, and later testing these on susceptible animals. A near source of natural infection would do much to obviate the disadvantage of the non-transmission of the disease by inoculation, since, when a case was required one might perhaps be obtained from a neighbouring farm, or soon produced by turning a susceptible animal on to infected veld.

A trip to the infected area of the Transvaal was made by invitation and at the expense of the Transvaal Government during late March and early April for the purpose of obtaining material and data for use in the investigation. A report on this trip, and its results so far

as obtained up to July last, when the report was written, was submitted to the Transvaal Department of Agriculture, and was subsequently published in the October issue of the Transvaal *Agricultural Journal*. Another trip to infected area was made between mid-November and mid-December; this time Bulawayo and vicinity was visited.

The tests thus far conducted have been almost entirely with the progeny of Blue and Brown Tick females from sick and recovered animals, and with nymphs and adults of the Brown Tick fed in the previous stage, that is when larvæ and nymphs, on sick and recovered animals. The results of the tests have been somewhat conflicting, and the only deductions which I yet (January 1st) feel safe in drawing is that the Brown Tick (*Rhipicephalus appendiculatus Neumann*) is a transmitter of the disease. The tick probably imbibes the infection at one stage and transmits it at a later stage of the same life cycle. Larval, nymphal, and adult progeny of females of the species, taken from sick cattle, have uniformly failed, in my tests, to transmit infection, as has also the progeny of Blue Tick (*R. decoloratus*) females from sick cattle. The Brown Tick is termed *Rhipicephalus sanguineus* by Dr. Koch in his reports. *R. sanguineus* is a species that I have not seen. It is recorded to occur in various parts of South Africa, and, from the descriptions given of it, must be very similar to *appendiculatus* in appearance. However, the two species are separated by Professor G. Neumann, who recently monographed the known ticks of the world, and from abundant material which I submitted to him he has identified the Brown Tick as *appendiculatus*.

The data concerning the only cases of African coast fever that have occurred at our experimental station is as follows:—

1. Ox No. 6, two years old, cross bred Kerry ox from Cape Flats. Procured in early September. Leg infested November 27th, 1902, with five female and two male Brown Tick adults. These ticks had been taken as engorged nymphs in the middle of October "from Kirrimuir cattle which sickened after dipping" and had been sent to me by Mr. C. E. Gray, the Chief Veterinary Surgeon of Rhodesia. They moulted at the office without the aid of artificial heat. Only the two males and one of the females became attached to the skin.

   Fever set in December 12th, fifteen days from the application of the ticks, and terminated fatally on the night of December 25th.

Mr. William Robertson, the Bacteriologist of the Veterinary department, watched the development of the case and he with Dr. D. Hutcheon, the Chief Veterinary Surgeon, conducted a *post-mortem* examination. Their notes read :—

Body emaciated ; a large amount of fluid in peritoneum.
Lymphatic glands, enlarged and hæmorrhagic.
Heart, some petechiæ on epicardium and fluid in pericardium.
Lungs had contained oedema (most had drained out).
Fourth stomach, slightly congested.
Liver, very much enlarged, contained numerous infarcts and hæmorrhagic areas.
Spleen, very much enlarged, softer than normal, weight 6½lbs.
Kidneys contained many infarcts. 37 counted in one.
Urine, the colour of dark sherry.

Mr. Robertson first found organisms in blood smears taken December 16th. In the smears made after death from blood (circulation), liver, kidney and spleen, he found them very numerous ; all were of the bacillary and spherical forms.

2. Ox No. 9, Cape-bred heifer, about eighteen months old, from Elsenburg in December, 1902. Leg infested April 1st, and ear infested April 8th and 11th, with male and female Brown Tick adults in large numbers.

All the ticks applied were taken *as adults* from dead cattle at Nelspruit, Transvaal, within a week of their being applied, and they were, therefore, merely *transferred* to the new animal. Their infectivity, however, depended, I believe, on the feeding in their larval or nymphal stage. Those applied to the leg failed to attach, so far as could be observed, but those applied to the ears bit freely.

Fever appeared April 22nd, that is fourteen days from the first application to the ears and and eleven from the second. Death occurred during the night of May 7th.

Mr. Robertson attended to the examination of the blood and to the *post-mortem*. His notes are as follows :

Heart showed several petechiæ on epicardium, and the surrounding fat was dark red in colour.
Lungs, slightly œdematous, no yellow fluid in interlobular spaces.
Spleen, a little enlarged, texture normal.
Liver, showed great changes due to parasitic irritation, probably fluke, and traces of chronic venous congestion, no signs of infarcts.
Gall bladder, distended with dark, dirty, yellowish-green bile.
Kidneys, showed principal lesions. Both simply studded with infarcts in all stages from bright venous red to white ; texture friable.
Bladder, full of sherry coloured urine.
Intestinal tract and mesenteric glands, normal.
Parasites in both rod and spherical forms found very sparingly in *post mortem* blood smears.

3. Ox No. 10, Cape bred ox, about eighteen months old, from Elsenburg early in April. Ears infested April 23rd with Brown Tick nymphs. These ticks were not counted, but they numbered about thirty ; about twenty fed to repletion. They came as engorged larvæ from two dead cattle during the last two days of March, and until they moulted to the nymph stage they were carried in a tube in my vest pocket.

Through an unfortunate mistake, the ox was inoculated on May 1st with blood from No. 9. Another ox, No. 11, however, was inoculated with the same quantity, 10 c.c., of No. 9's blood on the next day, and as it failed to give any reaction, it is safe to say that No. 10 was little, if any affected.

Fever appeared May 8th, fifteen days after the application of the ticks. On the 12th, the animal ceased to feed and on the day following it was down, purging and seemingly in pain from a large swelling under the jaw. Death occurred May 14th.

The *post-mortem* examination was made by Mr. Robertson, whose notes are:

Examination made while body still warm.

External appearances. Intermaxillary space swollen, the swelling extending as far back as angle of jaw. Slight discharge from nostrils of a yellowish fluid.

Swelling under jaw found to be a gelatinous oedema of a pale straw coloured fluid, and it completely filled up the space between the two rami.

Lungs, normal.

Heart of a bright red colour; auricles congested and petechiæ on epicardium.

Submaxillary lymphatic glands and those at base of lung much congested, oedematous, and quite black on section.

Petechiæ on diaphragm, pleural and periotoneal sides.

Bowels acutely congested throughout their length. Much matting of intestines with dark purple oedema. Intestines joined to liver.

Lining mucous membrane of caecum and small intestine much inflamed.

Lymphatic glands. Every one in body enlarged, oedematous and acutely congested. Superficial and deep inguinal glands affected.

Liver friable and dirty yellow in colour. No infarcts.

Gall bladder full of limpid green bile.

Spleen, enlarged, softer and darker than normal; petechiæ on capsule.

Kidneys, much congested, almost black in colour, friable; no infarcts (a typical redwater kidney).

Bladder full of dark claret coloured urine.

About a quart of blood stained fluid in peritoneal cavity.

NOTE.—I never saw a case in which the intestinal tract showed such signs of inflammation.

Microscopic examination. The *post-mortem* films contained parasites very few indeed in the blood and slightly more numerous in the kidney smears. The forms most frequently met with is the spherical; I saw one rod.

I was absent with fever when this ox died, and understood on my return that its death was considered due to ordinary redwater. Some time later, however, when discussing the case with Mr. Robertson, I found that no definite inference had been drawn; and then, in view of the fact that the lesions he observed and noted combined appearances ordinarily associated with African coast fever (swelling under jaw, enlarged glands, and intestinal inflammation), with appearances associated with redwater (enlarged spleen, congested kidneys without infarcts, and red urine), I requested that more smears be examined, with the view of determination by the microscope to which one of the diseases the case belonged. Mr. Robertson kindly favoured me, and reported:—

As a result of further microscopical examination of the blood films from ox No. 10, I find the parasites we associate with Rhodesian cattle disease fairly numerous, the spherical and ring forms being most common. I am unable to find any pyrosomas.

Despite the redwater-like appearance of the kidneys and urine, the case, therefore, seems by the microscopical examination to have been African coast fever. I may add that no case of redwater, or case of any disease except African coast fever that might be confused with redwater, has ever occurred at the experiment station or in its vicinity; and that up to the time No. 10 sickened, no animal suspected of having had redwater had ever come near the place.

Graphic charts to show the course of fever in all these animals are appended.

TICKS AND HEARTWATER.

Experimental tests, with the object of increasing our knowledge of the relations that exist between ticks and the stock disease "heartwater," were in progress throughout the whole year. The work accomplished, however, was less than in the previous year, owing to the lack of available stable accommodation, and the pressure of other work. There are still a number of tests that it is highly desirable to make, and the present notes are intended merely as a record of the more important results obtained in the period reviewed.

A number of failures by presumably pathogenic ticks to transmit the disease were encountered during the year. These were a source of much annoyance and loss of time, as they nullified the value of whole series of tests in which negative results were expected and obtained; but they indicate a line for new work that may disclose the explanation for the almost total absence of heartwater on the veld during the winter. Our failures all occurred in the winter and spring, and with ticks moulted at the natural temperature of the office; in other years infestations under such conditions were uniformly successful, but in the earlier work it was our practice to apply the ticks to the trunk of the body, whereas now we apply them to the feet and legs.

To secure uniformity with the previous records, the features of the year's studies to be discussed are presented under sub-headings.

A. INFECTION IS TRANSMITTED BY BONT TICK SOON AFTER ITS ATTACHMENT.—The incubation period of heartwater following infestation by pathogenic ticks is variable, the range thus far observed in sheep and goats under our experiments being eleven to twenty-three days. When the infecting ticks attach to the abdomen the period is generally twelve to fifteen days; and when to the feet and legs, from fifteen to eighteen days. Nearly all the tests are made with the nymphs (second feeding stage) of the Bont Tick (*Amblyomma hebraeum*), the only species of tick thus far found to be concerned with this disease. These nymphs are made pathogenic by being fed as larvæ, that is in the first feeding stage, on heartwater sick animals. They attach to almost any part of an animal, but feed up far more quickly in some situations than others, the time taken depending apparently on the supply of blood in the tissues of the particular spot. For the udder the time is often under five days, whilst for the feet it is rarely under ten, and often upwards of a fortnight. To determine if the prolonged term of inoculation when the infection was through the feet and legs were due to the ticks requiring the lengthened period for feeding when attached to these parts, the following tests were made:

1. Goat No. LXLIII. common ewe from Faure, in December, 1902. Infested leg, June 15th, 1903, with thirty Bont nymphs off No. LXLIV, March 27th-28th. Leg well covered to prevent escape of any specimens to the body and the limb thoroughly washed with paraffin oil at the expiration of twenty-four hours. The oil destroyed every tick and hence infection communicated by the ticks must have passed into the animal during the first day. Fever appeared June 30th, remained high through July 4th, and the animal was found dead on the morning of the 5th.

2. Goat No. CXI., common ewe from Faure, in May. Infested leg, June 15th, 1903, with thirty Bont nymphs of No. LXLIV., March 27th-28th, and leg kept well covered until washed with oil June 19th, four days later. None of the ticks had increased much in size by their feeding. Fever appeared July 2nd., the seventeenth day from the application of the ticks, and terminated fatally July 9th.

3. Goat No. CXXII., common ewe from Faure in early July. Infested leg July 14th, with twenty Bont nymphs taken off No. LXLIV. after death, and leg kept securely covered until washed with oil twenty-four hours after the application of the ticks. Fever appeared July 30th, the sixteenth day, and death occurred on August 3rd.

4. Goat No. CXXIII., common ewe from Faure in early July. Infested leg July 14th, with twenty Bont nymphs taken off No. LXLIV. after death, and leg kept securely covered until washed with oil twenty-four hours later. Fever appeared August 1st, the eighteenth day, and the animal died during the night of the 3rd. The lesions were found to be exceptionally pronounced.

In all of the tests great care was taken to prevent any of the ticks escaping from the legs to which they were applied, and to destroy every tick at the time indicated. The precautions taken to ensure that every tick was retained on the leg and there destroyed proved severe on the goats, and were all-sufficient to satisfy us that any infection transmitted passed over before the oil was applied. Therefore, the conclusions are drawn that infection ordinarily takes place within twenty-four hours from the time the infecting tick attaches, and that a long incubation period is not due to slow feeding on the part of the tick. The period between the application of the ticks and the advent of the fever was respectively, fifteen, seventeen, sixteen, and eighteen days, such a duration as our previous experience has taught us to expect when the infection is through a leg.

B. CATTLE ARE SUBJECT TO HEARTWATER.—Experiments reported on last year showed that calves contracted the heartwater disease when exposed to the attack of Bont Ticks made pathogenic by feeding on heartwater sick goats. This year older animals were exposed, and found to be likewise susceptible. The disease appears less fatal to cattle than to sheep and goats; and the *post mortem* lesions of the cattle that have died of the disease at the experiment stables have not been closely comparable with the lesions ordinarily found in cases of the disease in sheep and goats.

1. Ox No. 11, two year old ox from Stellenbosch district. Infested July 9th, with sixty or more Bont nymphs off Goat LXLIV. after death; fifty-five ticks recovered after feeding. Fever appeared July 25th, and temperature continued abnormal until August 1st (see Chart in Appendix). Illness hardly noticeable by animal's behaviour, and animal in health at end of year.

The character of the febrile reaction was determined by the inoculation of Sheep No. CXIX., a merino wether, on July 29th. Fever appeared in this animal August 7th, and it died of heartwater August 12th.

2. Ox No. 14, ox eighteen months to two years old from Elsenburg. Infested August 5th, on ear, with about fifty Bont nymphs off Goat LXLIV. after death. Only nine of the ticks engorged, one of these taking twenty-nine days. No certain fever at any time but animal became ill during the first week of September with a much disordered liver. On the 13th it died and a *post-mortem* examination was made by Mr. Robertson. He found a very severe invasion of liver fluke, over a pint of these parasites being taken from the intestines. The liver was small and hard. The gall bladder was immensely distended, and fully half-a-gallon of fluid was in the abdominal cavity. "The cause of death," Mr. Robertson entered in the experiment records, "might, I think, be put down to the effects of fluke and consequent interference with the functions of the liver."

   Although there was no apparent heartwater fever in this animal it was thought best to inoculate from it into a goat to test whether or not the ticks had failed in communicating infection. The goat, No. CXXXVI., was inoculated with 10 c.c. blood, on September 9th. It came into fever September 19th, after the normal incubation period from intravenous injection, and died of heartwater on September 23rd. Despite the absence of fever and of *post-mortem* appearances indicative of heartwater in the ox, therefore, this animal certainly had the disease; this infection may or may not have contributed to its death.

3. Ox No. 16, aged cow, reared in Cape District. Ear infested June 8th, with about one hundred Bont nymphs off Goat LXLIV, March 27th–28th; 63 recovered engorged June 16th to 20th. Very slight fever June 30th to July 14th, chiefly apparent in evening temperatures. Observed to eat much less than usual July 9th to 12th, and bowels loose at this time; on the whole, however, the health of animal little affected, and the fact of heartwater attack would have been questioned had not inoculations from the animal given positive results. Animal alive at end of year.

   On July 13th, bled and 5 c.c. blood injected into jugular of Goat CXXI. Fever appeared on July 21st, and terminated in the death of the animal from typical heartwater on the night of the 24th.

   On July 13th, 20 c.c. injected into jugular of Ox 12. Fever appeared July 25th, and the animal succumbed August 2nd. It was a young bull obtained from Elsenburg, and though much infested by fluke its death appeared due to the heartwater infection. The Veterinary Department took charge of the case and carried the strain of disease through two more oxen, with fatal results, and then through a series of Persian sheep. A discussion of these cases may be looked for in the Veterinary report, they being mentioned here simply as proof of the infection of Ox 16 by ticks.

These three cases of heartwater infection of cattle by ticks were controlled by the use of similar ticks, off Goat No. LXLIV., on the same dates and treated alike in all respects, on six common goats. All of the goats died as the result of the infection transmitted, an outcome in strong contrast with the mild disease produced in the three cattle.

Last year it was found that Bont larval and nymphal ticks off young cattle during a heartwater reaction are capable of transmitting the disease with undiminished virulence to other cattle and to goats; and, as it is now shown that an old ox (No. 16) is susceptible to the disease, it may safely be inferred that the farming of breeding cattle on infected veld is sufficient to retain

the disease. The deaths amongst the cattle due to this disease might be few, and these pass quite unrecognised as heartwater; but a widespread and highly virulent outbreak might at any time befall a flock of susceptible sheep or goats brought on to the place.

C. PERSIAN SHEEP ARE LIABLE TO HEARTWATER.—The experience reported by many farmers in the heartwater area that Persian sheep survive and multiply despite the disease led to the following tests being made to determine whether or not sheep of this breed are entirely non-susceptible; and if susceptible, but ordinarily not fatally affected, whether or not infection derived from them by the tick is as virulent as infection from less resistant animals. Persian sheep for the tests were secured from Worcester district through the kind assistance of Mr. A. G. H. Teubes, of Robertson. The animals were all wethers in good condition, and were very uniform in form, size, markings, and texture of hair; Dr. Hutcheon judged them to have six-eighths or more Persian blood. The ticks employed were Bont nymphs that as larvæ fell from Goat No. LXLIV., March 27th-28th, one day before its death from heartwater. Ticks of the same lot were used in the "A" and other tests, and transmitted uniformly fatal heartwater to a number of goats.

1. Persian Sheep, No. CVI. Leg infested with thirty ticks June 15th; twenty-four fed and recovered. Fever appeared July 2nd and continued until the 7th.
2. Persian Sheep, No. CVII. Leg infested with thirty ticks June 15th; twenty-four fed and recovered. Fever appeared July 1st and continued until the 6th.
3. Persian Sheep, No. CVIII. Leg infested with sixty ticks June 16th; forty-nine fed and recovered. Fever resulted July 3rd to the 8th.

The reactions in all these cases were strong fevers, as may be seen from the charts at the end of the report. Nevertheless the animals fed with undiminished appetite, and did not fall off perceptibly in condition, nor give other outward indication of the disease. Like all our other experimental animals, they were closely confined in sheds; it may be that if they had been on the veld under natural conditions they would have shown signs of weakness.

Attempts to rear Bont Tick larvæ on these sheep during their fevers were not as successful as was required for satisfactory tests of such ticks as nymphs; and for the double purpose of providing another sick Persian on which to rear ticks and to ascertain if an infection by inoculated blood would result fatally, Persian sheep No. CXX. was inoculated with 10 c.c. blood drawn from Goat No. CXI. when the latter was dying of heartwater. The goat, it is interesting to note, was infected by ticks of the lot used on the Persians. No. CXX was inoculated July 7th, and suffered fever without sickness July 19th to the 25th. The great resistance of this animal to infection that would surely have proved quickly fatal to goats or merino sheep made it seem quite unnecessary to test any more of this lot of Persians with ticks, a conclusion which has been supported by a series of inoculation experiments since conducted by the Veterinary Department. The sheep have reacted in all cases, but in none have been made seriously ill. A repetition of the tick work will be conducted during the coming summer with sheep of another lot.

The ticks from Sheep No. CXX. proved non-pathogenic to goats, but it is believed that their failure to infect was due to their having been moulted and kept at too low a temperature for them to develop the infective property. Ticks from No. CVI. also failed, presumably from the same cause. At the time of writing a repetition of the experiment with ticks from No. CLVII., a Persian subsequently infected by blood inoculation, is in progress, and fatal heartwater is resulting in the goats.

From the few tests made it appears that Persians are susceptible to heartwater, but that they are able to withstand the disease much better than goats or merino sheep. Further, it is becoming apparent that Bont ticks may become pathogenic through feeding on fevered Persians.

D. The Brown Tick is non-pathogenic as regards Heartwater.—The "Brown" (*Rhipicephalus appendiculatus* Neumann) is the species of tick associated

with African coast fever. It is one of the most widely distributed of the South African cattle ticks, and is a common parasite, in summer, of goats in the south-western districts of the Cape Colony. The specimens found in the Cape and Stellenbosch districts differ in a few characters from those found in eastern Cape Colony, Transvaal, and Rhodesia, but Professor Neumann, who named the species, thinks the differences too trifling to warrant a distinction being drawn between the two. However, it may be well to record that the specimens used in the tests which are here discussed were all of the local variety. Goat No. LXLIV., when in heartwater fever, was the host of the larvæ, and tests were made with the nymphs as follow:

1. Goat No. LXLVII., common ewe procured in Stellenbosch district. Leg infested May 27th, with many hundreds of Brown Tick nymphs off No. LXLIV., March 27th; about four hundred ticks recovered after feeding. No fever resulted.

   Same goat again heavily leg infested with Brown nymphs August 1st, this lot having fallen from No. LXLIV at death. No fever.

   Later subjected to leg infestation by twenty-five *Bont Tick* nymphs off No. LXLIV at death. Nine recovered after feeding. Fever appeared on twentieth day and animal succumbed to the disease five days later.

2. Goat No. CIX., common ewe from Stellenbosch district. Body infested May 28th with large number Brown nymphs off No. LXLIV. on March 28th. Three hundred and fifty recovered after feeding. Irregular temperature prevailed between the eighth and seventeenth days, but this disturbance attributed to irritation caused by the ticks. No distinct fever resulted.

   Susceptibility of this animal to heartwater determined by infecting it with ten *Bont* nymphs off a heartwater case, June 24th. Fever appeared July 10th and death followed, July 13th.

3. Goat No. CXXXII., common ewe from Stellenbosch district. Leg infested August 1st, with hundred or more Brown nymphs off No. LXLIV., March 27th-28th, but only five recorded to have been recovered after feeding. No fever.

Still other tests of Brown Ticks nymphs were made, but they cannot be accepted as evidence, because of the failure of Bont Tick nymphs under exactly similar conditions. The three tests cited were checked by tests with Bont ticks, off No. LXLIV. on the same date, which yielded positive results; therefore there appears to be no reason to doubt the inference that the Brown Tick is not a transmitter of heartwater; but to settle the question more satisfactorily it is proposed to repeat the tests during the summer season.

TICKS AND MALIGNANT JAUNDICE.

Malignant Jaundice is the dog disease commonly known in South Africa as distemper, or hondziekte. The name here adopted is the one preferred and long used by the Cape Veterinary Department; the terms malignant malaria and bilious fever have also been applied to the disease by veterinarians. As the most serious, and one of the most common diseases affecting dogs in the country, its own importance warranted the attention I have given to its means of transmission from animal to animal; but the real inducement to study its means of dissemination was the hope of acquiring knowledge that might prove of value in later investigating diseases of other animals that are of greater economic consequence. Malignant jaundice is one of a large number of diseases of man and lower animals due to the presence and multiplication of protozoan organisms in the blood; and these diseases, with others of more obscure nature, as, for instance, heartwater, horse-sickness, and yellow fever, are probably all dependent on blood-sucking parasites for their transmission from animal to animal. The exact channel of infection is known in a few cases only, and, therefore, each new fact discovered in relation to the transmission of any one is a matter of considerable scientific and economic interest since its application may be general.

Nature of the Disease.—The Bacteriologist of the Cape Agricultural Department, Mr. Wm. Robertson, in an article which appeared in the *Agricultural Journal* for June 5th, 1902, says: "It (malignant jaundice) may be roughly defined as a malarial disease affecting dogs, communicable by direct inoculation from animal to animal, but not by cohabitation or ingestion, and due to the presence of a hæmatozoon in the red blood corpuscles." Dr. Hutcheon, the Colonial Veterinary Surgeon, long ago (*Agricultural Journal*, November 30th, 1893) pointed out the similarity of the disease to redwater in

cattle and biliary fever in horses; and we now know that these three diseases are due to three closely related micro-organisms that live at the expense of the red corpuscles, being respectively called *Piroplasma canis* in the case of the dog disease, *Piroplasma bigeminum* in redwater, and *Piroplasma equi* in biliary fever.

The symptoms of malignant jaundice and the *post mortem* appearances of the viscera of dogs that succumb to it were described at length by Mr. Robertson in the article by him above referred to, and I need only mention the superficial characters. The animal attacked first shows illness by its rapidly losing flesh, lacking appetite, becoming listless and lying quietly curled in one position for hours at a time. If its temperature is being taken regularly, fever will be evident before any other symptom; but a reading taken when illness is manifest may be normal, as a remission of the fever is characteristic. As the disease progresses, anæmia becomes pronounced, the inside of the eyelids, the gums, and other visible mucous membrane becoming pale and bloodless; there may, too, be a yellowish tint to these parts, and almost always distinct jaundice shows on the thin skin of the abdomen. If the blood be superficially examined it is seen to be thin, watery, and slow to clot. The urine generally, but not always, becomes blood coloured. Some dogs die within twenty-four hours of indicating illness by their appearance, but most generally linger on for five days at least, and die from apparent exhaustion after the fever is spent. The most marked features on opening an animal which succumbs are a jaundiced condition of the fatty and connective tissues, a greatly enlarged liver, a still more relatively enlarged spleen, and, generally, reddish urine. Some dogs make a good recovery, and in a month or six weeks are again perfectly healthy; others remain emaciated for many months, but gradually become restored, whilst still others contract nervous disorders and remain permanently affected.

The dog only is known to be subject to the disease, and no breed appears to be exempt. The better bred the dog, the more severely the disease appears to affect it; but fatal cases seem to be not uncommon amongst the meanest curs kept by the natives. Young dogs, seem-

ingly, are as severely affected as adults, as in the experiments to be described later on mere pups speedily succumbed to infection. Mr. Robertson inoculated a horse, an ox, a sheep, a cat, a fowl, a guinea pig, a rabbit, a rat, and a mouse with blood from a sick dog, without in any case reproducing the fever. As will later be shown, a jackal was infested with pathogenic ticks and inoculated with virulent blood without its becoming infected.

Occurrence of the Disease.—The disease appears to occur throughout the British South African colonies, but to be far less prevalent in high inland districts than near the coast; this occurrence corresponds with the distribution and numerical abundance of ticks. Dr. Hutcheon mentioned that it was known in Europe in his article written ten years ago, and stated then that it appeared to be more common in the Colony than there. Recently it has received close attention at the Alfort Veterinary School in France, in the southern part of which country and in the warmer parts of Italy it appears to have been well established for many years. Reference to its occurrence in East Africa, and in Senegal on the West Coast, is made by Mr. Robertson in his paper.

Whether or not the disease is native in South Africa is unknown, but it has certainly been established in parts of the Colony for a long time. Mr. Robert Warren, of Avoca, Kei Road, distinctly remembers it as far back as 1844, at Graham's Town. Mr. J. B. Currey, of Vergelegen, Mowbray, recollects cases in the Lange Kloof, Humansdorp, in 1853 or 1854. A fatal case at Cradock about 1846, in a pet dog of his, is recalled by Mr. W. E. Murray, of Roodebloem, Graaff-Reinet. Several Cape Town people remember that it was common about the city thirty years or more ago, and Dr. Hutcheon found it widely prevalent when he came to the Colony in the early eighties. A prominent Natalian, of whom I chanced to enquire, says he has known it ever since he took up his residence in Natal, about 1880. Probably the disease was at the Cape very much earlier than any of these references indicate. In the published

letters of Lady Anne Barnard ("*South Africa One Hundred Years Ago*," p. 110) is a letter from the Cape dated 29th November, 1797, which contains this significant phrase which I italicize: "As we drove along, we saw our only English dog *who has survived the ailment which attacks all who arrive here*, who is a stout vulgar pointer. . . . pointing at something." In the lack of any other common and usually fatal disease, there is little reason to suppose the reference not to malignant jaundice.

However, there is a little evidence that the disease has not always been known in districts where it now occurs. Mr. H. Dugmore, of Mount Donkin, Bathurst, has told me that when farming near Bowden, in the Albany district, before 1860, his people kept many dogs; and that about the year mentioned the disease appeared, and killed every one. A similar experience was related to me by Mr. L. S. de Wet, who has all his life lived near Rawsonville, in the Worcester Division. He said he clearly remembered that many dogs were kept on his father's and surrounding farms in his boyhood; and that about 1860 the disease appeared in the neighbourhood and swept off nearly all of them. Since that time it has been very difficult to rear dogs thereabouts. In both these cases it is possible that the immunity of the dogs prior to the outbreaks might have been due to local absence of the particular tick that carried the disease, or to the non-introduction locally of any sick or salted dog which might start the infection of ticks already present; the local dogs might, perchance, have been brought to the farms as susceptible pups, or been bred from such dogs later.

It appears possible for the disease to be stamped out on a farm. When the fact of its transmission by a tick was published, Mr. Robert Warren, above mentioned, wrote:

> "I have been much interested in the account of your experiments with ticks as a means of transmission of distemper amongst dogs. This part of the country has a bad reputation for what we have always termed 'distemper,' so much so that it was difficult to rear good dogs. But some years ago a couple of pups introduced red mange on to the farm, and it was two years before this trouble was overcome. Following on the mange, we had a plague of a kind of flea which would bury itself in the nose and ears of the dogs. To get rid of these troubles we resorted to dipping the

dogs in Little's sheep dip and other mixtures. Now I come to the point that will interest you. We have to keep a pack of small dogs on account of jackals being so troublesome. Several litters of pups have been reared during the last four or five years, but none of them have had distemper, nor have any of the grown-up dogs. Some time ago I remarked that the distemper germ seemed to be stamped out on the farm, not for one moment thinking that the germ was conveyed by ticks. Now I am convinced that the tick theory of infection is correct, and that the disease was stamped out by the constant dressing and dipping of the dogs."

It may be that the dipping kept the tick greatly reduced in numbers, and thus caused an elimination of the infection. But Mr. Warren, after writing the above letter, made inquiries amongst his neighbours, and elicited the fact that the disease is not now nearly so serious on their farms as it was some years ago. Fifteen years ago, he writes, only about one dog in five could be reared in the neighbourhood.

The virulence of the infection undoubtedly varies greatly, and even a mild attack appears to confer a high degree of resistance to a later infection of a strain that would prove quickly fatal to fully susceptible animals. On some farms nearly every dog recovers; on others nearly every one, or even every one, dies, many of them after having shown symptoms of illness for only two or three days. This variability of the virulence is probably the true explanation of why remedies which are apparently infallible with some parties are wholly devoid of value in the hands of others. Nearly every farmer and other dog-owner has his favourite method of treatment. Some dose with Carter's liver pills, others with Beecham's pills, castor oil or other purgative, others with emetics of various sorts. Haarlemensis or Haarlem oil is a favourite remedy with many, and not a few extol calomel as the only one of numerous drugs tested that ever has proved of any service. The removal of the small tendon under the tongue is a cruel practice which is widely believed to be most efficacious; it may perhaps assist by preventing the poor victim from taking food when food aggravates the disease. The Colonial Veterinary Department has experimented with many drugs without finding any one of much value. Calomel seemed to help more than anything else. Mr. R. Bromley, of Rondebosch, says he is very successful with calomel, but he uses it in tremendous doses. His plan is to give a

pill containing twelve grains of calomel and twenty of jalap when the disease is first observed; then if no improvement is noticed within two days a second pill of the same sort is given, followed a few days later by a third if the case is obstinate. The strength of pill mentioned is for dogs as large as a year-old pointer. He gives eight or ten grains only of calomel to small dogs, and may omit the jalap after the initial dose. But whatever the medicines used the consensus of opinion is that the sick dogs must be kept warm and quiet and not harassed with food. When they begin to mend they should be fed only on easily digestible food, as warm milk, and that in small quantities; and they should not be violently exercised. I believe a number of the dogs used in our experiments died, after the fever was spent, from nothing more than being allowed to eat too freely of the ordinary dog fare.

THE TRANSMITTING TICK.—The experiments to be recorded have demonstrated that malignant jaundice is transmitted by the common dog tick of South Africa. This is a species of *Haemaphysalis* which Professor G. Neumann has pronounced to be *H. leachi* Audouin. In Professor Neumann's monograph on ticks, this species is recorded from various places in the north, east, south and west of Africa and from a few places in Sumatra and eastern Australia. From his references, the species appears to be almost if not wholly confined to carnivorous animals, the lion, tiger, leopard, wolf, dog, cat, etc., all being attacked by it. Personally, I have only taken it from the domestic dog and cat, but have fed many adults on a jackal. Professor R. Koch, in his first report on African coast fever (see *Cape Agricultural Journal*, July, 1903, p. 37) mentions that he now and then came across specimens on cattle at Umtali, Rhodesia, and Professor Neumann, in his work, states that he received one specimen taken from a horse in New South Wales. About Cape Town it is certainly not common on any domestic animals other than dogs and cats, though now and then single specimens are seen on cattle.

The dog tick is very easily reared. All stages freely attach almost anywhere on the skin of a dog. The

larva and nymph both drop from the host to moult. They both feed up quickly, and may drop in less than forty-eight hours from the time they attach; more usually, however, they remain from sixty to seventy-five hours. The time consumed in the change from one stage to the next varies with the warmth to which the tick is exposed. In summer the engorged larva may transform to the nymph in ten to twelve days, and the engorged nymph transform to the adult in eighteen to twenty days; in the winter the same transformations may take ten to fifteen weeks (at Cape Town), but the development will continue and the change take place even if the specimens be kept in an ice-box where the temperature ranges about 55° F. Neither the larva nor the nymph of the species is particularly anxious to hide away in the soil rubbish to moult as is the case with most cattle ticks; instead, both would rather stow themselves in crevices of wood, bark, or bones, just such places as they would naturally find in a dog kennel or about the lair of a carnivorous animal. Many times I have very successfully moulted them amidst crumpled bits of dry paper within a corked glass specimen tube; most cattle ticks similarly confined would fail to moult. The two sexes attach without reference to one another, but get together after two or three days. Both sexes move about more or less in quest of more favourable feeding positions, and perhaps also to find mates, as in my experience marked males have moved and settled by females, and marked females moved and settled by males; but the male appears to be the usual one to move and seek a mate. The females feed to repletion whether or not they are joined by males, but such unmated females have laid only infertile eggs when I have retained them. It generally takes ten days for a female to feed up; a few specimens are replete by the eighth day, and many hang on from twelve to fifteen. The males remain for several weeks, and may mate with more than one female. The dropped females hide themselves in rubbish, seldom burrowing into soil as do most cattle ticks, and soon lay their complements of eggs. I have attempted to count the number of eggs in one batch only, and then found about forty-two hundred. At Cape Town, the eggs

begin hatching five to seven weeks from the time the female drops in summer, and twelve to sixteen weeks in winter. Three successive generations have been easily reared in fifteen months, but ordinarily probably not over two generations are passed in a year out of doors. No other tick that I have reared is so quick to leave its host at death. There have been few females on any of our dogs at death, but males have been common several times. As soon as the animals began to grow cold, even several hours before death in some cases, the ticks loosened their hold and crawled restlessly amongst the hair, many of them finally reaching some relatively elevated position as the point of an ear, and coming to a rest as if there to await a new host; some crawled quite away from the bodies.

The common dog tick of Europe is generically distinct from the South African species, and as our tick is not recorded from there at all, it follows that more than one kind of tick must be capable of transmitting malignant jaundice. It may be that more than one kind is concerned in South Africa. Whilst *Haemaphysalis leachi* is the most generally distributed, as well as the most abundant kind of tick on dogs here, other kinds are not uncommonly seen on the animals in some sections. In Stellenbosch the Russet Tick (*Ixodes pilosus*) is frequent on dogs, and *Rhipicephalus capensis* is sometimes found. At Nelspruit, in the Transvaal, a few examined were found to carry more adults of the Pitted Black Tick (*Rhipicephalus simus*) than of the ordinary species, and a few adult specimens of the Brown Tick (*Rhipicephalus appendiculatus*), the Bont Tick (*Amblyomma hebraeum*), and the Bont Leg Tick (*Hyalomma aegyptium*) were found on the same dogs. In tick-rearing work at the experiment kennels, I have found that the Blue Tick (*Rhipicephalus decoloratus*) may be reared on dogs, and that the early stages of the Bont Tick and of the Red Tick (*Rhipicephalus evertsi*) may feed to repletion; also no trouble at all has been experienced in getting the Tampan (*Onithodoros savignyi*) to accept a canine host. Only a very small proportion of the specimens of the Blue, Red and Bont kinds that have been applied, however, have succeeded in feeding;

and I have thus far wholly failed in attempts to rear larvæ of the Pitted Black Tick on dogs, not one of many thousands applied having fed to repletion.

WHEN AND HOW THE TICK BECOMES INFECTIOUS.—The infection of the animal does not originate, of course, from the mere bite of the tick. To communicate the disease the tick must have a virus to transmit that was derived some time before from an animal whose blood was infectious. The tick is normally innocuous except for the slight irritation it causes by its bite and for the trifling quantity of blood which it takes; indeed hundreds of the tick may and often do attack a susceptible dog and cause no more injury to the health than would so many fleas.

The relation of the disease to redwater in cattle first aroused the suspicion that a tick was the channel through which the disease spread from dog to dog, the fact that redwater was thus spread having been demonstrated by American investigators. Naturally suspicion fixed upon the one common dog tick, and towards the end of 1900 experiments were started to determine if the suspicion was well founded. The result has been to clearly establish the fact that the tick is the medium of infection. However, the transmission is not so simple as is presumed to be the case in redwater, which is supposed to be transmitted by the *larval* progeny of ticks off affected animals. The dog tick is found to communicate malignant jaundice only in the *adult* stage of its life, and then only when in the adult stage of the preceding generation it imbibed infectious blood.

The source of the infection may be either a dog actually ill with the disease or one "salted" to it, that is, a healthy dog immune through having had an attack. Presumably, the recovered dog is a more common source than the actually sick one, since it is about continually. The sick dog dies or recovers in a few weeks; and whilst ill it is apt to remain helpless in its sleeping-place and its vicinity be visited by fowls or birds on the look-out for such dainty morsels as engorged ticks. It is probable, however, that many and perhaps generally most of the progeny of ticks which fall from recovered dogs

are not carriers of the virus, and are quite as harmless as the progeny of ticks from susceptible animals. Similarly, it is unlikely that every one of the thousands which arise from a mother off an actually sick dog is pathogenic. Susceptible new dogs often live in localities for several months where all other dogs are salted to the disease and yet escape an attack, although they become much infested with adult ticks that must have come from mothers dropped by the longer resident recovered dogs. Moreover, progeny of ticks off dogs that have lived through the disease have failed to communicate infection in some of the tests which have been made.

A single pathogenic, that is organism-containing, tick is probably ample to communicate infection that may lead to death. The smallest number of ticks actually applied in the tests with the result of producing the disease was ten. This number and twelve were both twice tried with success, and death followed in all four cases. Probably, too, the virulence of the attack induced by ticks depends far more on the quality of the infection which the ticks communicate than upon their numbers. The cases produced by the use of what will be called Lot 4 ticks in the recital of tests to follow were materially milder in type than those resulting from Lots 2 and 3 ticks, although the number of ticks applied was greater.

In determining if the bite of a single tick will transmit the disease, tests resulting negatively would be inconclusive, unless many times repeated. It seems possible that a tick might lose the capacity to infect or that the infection which it did transmit might fail to become absorbed and reach the blood. Furthermore, it is not unreasonable to suppose that many ticks are quite innocuous despite being the progeny of parents that fed on highly virulent blood. The microscopical examination of virulent blood, that is the blood of an actually sick dog, shows that a very small and variable number of the red corpuscles are invaded by organisms of the disease. The examination of a recovered dog's blood discloses none of the organisms, as a rule; but, presumably, there are some present, though too few to be observed, as the inoculation of blood from a recovered dog (at least for

several months after its sickness) produces the disease in a susceptible dog, like the inoculation of blood from a sick one, with the difference that a materially larger quantity must be used. Perhaps, altogether, a third of one cubic centimetre of blood is sucked up by the mother tick; and these few drops have to suffice for her own nourishment and for the production of the several thousand eggs which she has to develop. In these vital processes, one to two millions of corpuscles, drawn up whole into the body, may be broken up and used, and if the blood came from a dog at the height of the fever a hundred thousand or more of these corpuscles may have contained disease organisms. It is likely that a vast number of the organisms perish in the changes, but that those that survive undergo development with multiplication. However changed in form and number they become, however, the organisms must remain very small in bulk compared to the bulk of assimilated food that is ultimately transformed into eggs, and the chances hardly seem good that every one of the thousands of eggs receive a share in their distribution. But even if every egg does participate in the division, it is hardly conceivable that enough to secure the infection of an animal will always survive through the periods of embryonic development, the metamorphosis of larva to nymph and nymph to adult, and the often prolonged fasts of larva, nymph and adult whilst awaiting a host, and then finally will be lodged within the adult whence it will be successfully ejected into the flesh of a dog victim.

Whether or not a tick is injuriously affected by being a carrier of the infection is unknown; but the individuals of the various lots of pathogenic ticks which have been reared have appeared quite as vigorous, active and long-lived as the individuals of the lots of non-pathogenic ticks that have been under observation. There is always a tremendous mortality amongst ticks, probably not one in a hundred hatched living through all three feeding stages, so fine distinctions in the healthiness of different lots cannot easily be drawn.

Cases of the disease have been produced at all seasons of the year through tick infection; and so far as could be observed the virulence was affected neither by the season

nor by the duration of the interval between the acquirement of the infection by the tick and the transmission to a new animal. The metamorphoses of the ticks employed to produce some of the cases were hastened by keeping the specimens at a constant high temperature in an incubator, and those of others retarded by the use of an ice-chest. Under natural conditions, the disease also occurs at all seasons; but it is generally much more common during some months than others in any given district, its prevalence doubtless depending on the circumstances influencing the development of the tick. About Cape Town, the cases brought to my notice have been most numerous in the fall and early winter, that is, during the first half of the rainy season; but a gentleman residing at Rondebosch, who keeps a number of dogs and who has been familiar with the disease for many years, tells me that more cases occur in October than in any other month.

Young pups have seemed to be fully as susceptible and as severely affected by the disease as adult dogs in the tick experiments and in blood inoculation experiments. It is a common observation amongst farmers, however, that dogs are usually several months old before they contract the disease, and that dogs are usually safe from it after they are two or three years old. The explanation may be that pups are rarely taken into the veld, and, therefore, are little exposed to tick attack compared with older dogs; and that dogs two or three years old have generally had the disease. Ticks drop from dogs about the homesteads even more numerously than elsewhere, perhaps, but there is comparatively little cover for them, and fowls are usually about that will pick them up.

It has been intimated that it is possible that more than one kind of tick can convey the infection. If other kinds do carry it, it is probably from one generation to the next, and very likely it is then transmitted only by the adult ticks, as in the case of *Haemaphysalis leachi*. The Bont Tick, when fed as an innocuous larva on a heartwater-sick animal, gets infection of that disease that it will transmit to a susceptible animal when it next

feeds; but the Bont Tick, to judge from one test made, is quite incapable of thus deriving and transmitting the infection of malignant jaundice. So also is the Dog Tick itself and the Tampan Tick. Adult dog ticks taken directly from a sick dog, and placed on a healthy dog, may or may not give the disease, but even if they do, the infection transmitted is probably not from the sick dog from which they were taken, but from the dog on which their parents fed. The direct transmission of infection by a blood-sucking fly, which bites more than one animal within a few hours, is conceivable; but the indirect and remarkable transmission by the tick is undoubtedly the natural method.

Experiments.

The statements in the paragraphs under the last subheading are largely deductions made from the results of experiments conducted during the past three years with the definite object of ascertaining how and by what parasites the disease is transmitted. Their value may be judged by a consideration of these experiments. They are given below, and to facilitate a ready comprehension of the scope and bearing of each, they are arranged under pertinent headings.

It is proper to explain that the Veterinary branch of the Department, chiefly through Mr. Wm. Robertson, its Bacteriologist, has been engaged in studying malignant jaundice from the veterinary and bacteriological standpoints, whilst my office has experimented to elucidate the avenue of transmission. I have pleasure in acknowledging that to the Veterinary branch I am indebted for authoritative confirmation as malignant jaundice of nearly all the cases of the disease produced in my experiments, such confirmations being made by examination of blood smears or by *post mortem* examination of the viscera, or by both. In return for this assistance I have rendered aid to its phases of the investigation in numerous ways, such as providing reared pathogenic ticks for crushing experiments and for sectioning, by assisting at inoculations, and the taking of smears and keeping of temperature and other records

of inoculated animals during Mr. Robertson's long absences.

The dogs for the experiments were all obtained in or about Cape Town. Many were purchased, but most were procured for the asking from the "dog's home," the municipal institution to which unlicensed and stray dogs are taken by the police authorities. The municipal storekeeper, Mr. Percy Clutterbuck, has my thanks for providing these animals. Control dogs were always kept, and, as a rule, most of the dogs used were kept in the kennels for a fortnight or more before being brought into an experiment. Dog biscuits, varied with goat flesh occasionally, was used as the food; the young puppies were given diluted condensed milk. Few of the animals were given medicines when ill, the disease being allowed to run a natural course. Sick dogs were generally isolated for their comfort, were kept well supplied with dry beds in the form of bagging, and given warmed condensed milk.

A. INFECTION TRANSMITTED BY ADULT PROGENY OF THE DOG TICK WHEN FROM A SICK OR RECOVERED DOG.—The first experiment conducted was a test of nymphal specimens of the tick, which as larvæ had been fed on a sick dog. No infection resulting, the progeny of adult ticks taken from presumably infectious sources were naturally tested, the infection of redwater being known to pass to the progeny. The leading facts in regard to the progeny tested, and the dogs on which the tests were made with positive results, were as follow:—

1. Lot 1 ticks, the mixed progeny of females collected December 16th, 1900, a few from a sick dog and a few from a long recovered dog. Fed as larvæ during January and as nymphs during March on Dog No. 0.
   (*a*) Dog No. 0, mongrel pup, born in October, 1900. Infested March 11th and on several subsequent days with Lot 1 adults. Fever appeared about April 2nd. Chloroformed when slowly dying April 10th. Diagnosis as malignant jaundice confirmed by *post-mortem* examination and finding of the organism in blood smears.

Lots 2, 3, and 4 were progeny of females removed from actually sick dogs.

2. Lot 2 ticks, the progeny of females taken off Dog No. 0, April 10th, 1901, when animal dying. Reared as larvæ and nymphs on Dogs 1 and 2 in June and July.

(*a*) Dog No. 1, fox terrier pup, born about May 15th. Infested August 27th with about 40 Lot 2 adults. Fever appeared about September 8th, and terminated fatally on the 11th. Diagnosis confirmed by *post-mortem* examination and the finding of the organism in blood smears by Mr. Robertson, also by reproducing the fever through inoculated blood in Dogs 3 and 4.

(*b*) Dog No. 2, sister pup of Dog 1. Became infested by strays from No. 1 and sickened same day as that animal. Died September 10th. Lesions typical and organism in blood.

(*c*) Dog No. 6, Irish terrier pup, born about August 12th. Infested with five males and five females of Lot 2 adults, September 23rd. Fever appeared October 5th and death followed on the 9th. Lesions typical and organisms in blood. Ten males and ten females of same lot of ticks had been added September 25th.

(*d*) Dog No. 8, black and tan adult mongrel, standing about fourteen inches high at shoulder. Infested with five males and five females of Lot 2 adults September 23rd. Three females and one male at least became attached. Animal isolated in shed by itself so only the ticks applied could possibly reach it. Fever appeared October 4th, and ended fatally on the 15th. Lesions typical.

3. Lot 3 ticks, the progeny of a female off Dog 6 on October 6th (2nd day of fever) and two off Dog 8 on October 4th (1st day of fever). Fed as larvæ on Dog 7 in December, and as nymphs on Dog 15 in January.

(*a*) Dog No. 18, large, heavy adult fox terrier. Infested February 3rd with six males and six females Lot 3 adults. Ten males added February 7th. Fever appeared February 21st and terminated fatally March 5th. Frequent and heavy doses of calomel given and illness probably thus prolonged. Diagnosis confirmed by *post-mortem* and blood examinations by Dr. G. W. Robertson, of Medical Officer's Department.

4. Lot 4 ticks. No female ticks were recovered from Dog 18. A fine lot, however, were secured in July, 1902, from a pointer dying from fever contracted on the Cape Flats. This dog's case was confirmed by inoculation of blood from it into susceptible dogs. Progeny of the ticks fed as larvæ and nymphs during October and November on Dogs 56 and 57 (young pups).

(*a*) Dog No. 53, Small fox terrier adult. Infested December 9th with twenty-five male and female adults of Lot 4. About forty more applied December 15th. Fever up December 22nd and continued until January 1st. Passed reddish urine January 2nd to 4th. Seemed certain of complete recovery on January 12th and on that date destroyed.

(*b*) Dog No. 56, small mongrel puppy, born about the middle of September, on which with No. 57 all the Lot 4 ticks were fed as larvæ and nymphs. In poor health when infested December 22nd with twelve females of Lot 4. Came into fever January 1st and died January 6th. Opened by Dr. Hutcheon and the typical lesions observed.

(*c*) Dog No. 57, sister pup to No. 56, and like it afflicted with worms. Infested December 22nd with twelve females of Lot 4 and isolated in company with No. 56. Came into fever January 1st and died January 5th. Opened by Dr. Hutcheon and diagnosis as malignant jaundice confirmed.

(*d*) Dog No. 59, rough haired adult fox terrier. Infested December 22nd with thirty-eight females of Lot 4. Fever appeared January 1st and ran typical course to the 10th. The chances for a complete recovery seemed very good on the 12th, but on that date animal destroyed.

Dog No. 60, small fox terrier adult. Infested December 22nd with forty-five males of Lot 4. Fever appeared January 4th and terminated fatally January 11th. Not opened, but jaundice very pronounced and urine red.

(*f*) Dog No. 61, small fox terrier adult. Infested December 22nd with fifty-five males of Lot 4. Came into fever January 2nd. Destroyed January 12th, at which date it looked as if almost certain of recovering.

(*g*) Dog No. 62, small mongrel adult. Infested December 22nd with sixty males of Lot 4. Came into fever January 2nd. Destroyed January 12th. Was not very ill and was vicious to the end.

(*h*) Dog No. 63, medium sized fox terrier adult. Infested December 22nd with ten females of Lot 4. Two of the ticks seen on the skin December 27th and more probably attached, but *no fever produced*. Infested January 7th with fifteen more females of same Lot. Fever appeared January 18th, and ran a typical course of high temperature without much affecting the dog's appetite or checking its bark. Destroyed February 12th.

(*i*) Dog No. 66, adult mongrel, the size of a fox terrier. Inoculated by Mr. Robertson with serum January 16th, and on January 21st about forty Lot 4 adult ticks, applied to determine if serum gave protection. Fever came up on February 1st and death took place on the 8th.

(*j*) Dog No. 67, adult mongrel. Treated in all respects like 66, and fever appeared on same day. Died February 14th. *Post-mortem* examination by Mr. Robertson revealed the typical lesions.

(*k*) Dog No. 71, large Irish terrier adult. Inoculated by Mr. Robertson February 9th with blood pressed from ticks taken off sick dogs, but no reaction produced. To test its susceptibility, infested March 3rd with thirty males and females of Lot 4. Came into fever March 16th and died with typical lesions March 22nd.

(*l*) Dog No. 74, fox terrier adult. Inoculated by Mr. Robertson February 10th with crushed remains of about fifty Lot 4 adults in water medium. No reaction to March 3rd. Then infested with thirty other specimens of same kind. Fever appeared March 13th and ran the typical course without causing great prostration. Destroyed March 31st when daily growing stronger.

The following lot was the progeny of females taken off a dog that had fully recovered its health:—

5. Lot 5 ticks. This lot was entirely the progeny of females taken off a salted dog. The animal (No. 54) had had a relatively mild course of fever following blood inoculation, October 24th, 1902, and was in normal health and temperature when the parent ticks were fed in early January. The larvæ and nymphs were reared on two healthy puppies during February and March.

(*a*) Dog No 72, adult mongrel, size of a large fox terrier. Infested April 29th with about seventy-five adults of Lot 5. Fever appeared May 9th, and animal died on 13th. Blood smears examined by Mr. Robertson, and typical organisms found in abundance.

(*b*) Dog No. 75, adult mongrel. Infested April 29th with about seventy-five Lot 5 adults. Fever came up May 10th, and death followed on the 20th. Fever curve and symptoms typical.

(*c*) Dog No. 76, adult mongrel. Infested as were Nos. 72 and 75. Fever came up May 9th, and animal died May 19th. Course of fever and symptoms typical.

Some of the surplus ticks of Lot 5 were sent to Dr. A. Theiler, the Veterinary Bacteriologist of the Transvaal, who soon afterwards wrote: "I placed the dog

ticks on two dogs, and both sickened after about ten days and died of malignant jaundice."

B. FAILURES TO INFECT BY ADULT PROGENY OF TICKS FROM SICK AND RECOVERED ANIMALS.—Amongst the many dogs to which Lot 4 adult ticks were applied not one failed to become affected, although the strain of the diesase transmitted appeared to be much milder than what was obtained from the other lots of ticks. One failure was experienced in the use of Lot 3, the parents of which were taken off sick dogs very soon after the fever came up.

(*a*) Dog No. 21, rough-haired adult fox terrier. Infested February 17th, 1902, with five males and two females of Lot 3. Not thoroughly examined until sixth day, and then only one tick, a female, discovered. No fever.
(*b*) Dog No. 18 that died from the attack of ticks of this lot may not have been infested by the first ticks placed on it; if it was, the incubation period, eighteen days, was unusually long.

Another failure occurred with the use of a few ticks that were the progeny of a female, taken off a sick dog in the country, which was sent to the Veterinary Department. There seemed no doubt that the host dog was suffering from the disease. The rearing of the progeny was very unsuccessful, only four living to become adult.

Dog No. 7, small fox terrier pup. Infested November 10th, 1901, with three males and one female. The males attached, but the female were never located. No fever.

These two failures are not worth much consideration, but the following ones, all from one lot of ticks, are very instructive, in showing that a large proportion of the progeny of ticks from infectious sources may chance to be non-pathogenic.

.... Lot 6 ticks. Progeny of seven females taken off Dog No. 17, February 7th to 9th, 1902. Dog 17 was animal infected by inoculation of blood from a recovered dog January 7th, 1902. It had fever from January 13th to 24th, on February 1st, February 12th to 18th, February 25th to 27th, and March 12th to 14th. It went "off feed" January 14th, and took almost no food, except milk, until March 1st, after which it took a little biscuit daily. All along after the first onslaught of fever it was extremely anæmic, and no hopes of its recovery were entertained until March. On the 12th and 13th of this month it was tempted to eat a little cooked meat, but fever came on at once and death occurred on the 16th. Organisms of the disease were found by Dr. G. W. Robertson, of the Medical Officer's Department, in smears taken on January 14th, and on many subsequent days to and including February 6th, and some also were observed in smears taken February 17th. Therefore organisms were certainly in the blood in observable numbers, whilst the parents of Lot 6 ticks were feeding. Lot 6 larvæ and nymphs fed on three puppies in March and April respectively.

(*a*) Dog No. 36. small poodle. Infested June 4th with thirty-five adults of Lot 6 ticks. No fever. Animal destroyed August 1st.

(*b*) Dog No. 37, black mongrel, size of bull terrier. Infested June 4th with about forty adults of Lot 6 ticks. No fever. Proved susceptible four months later by inoculation with 1 c.c. of blood from a recovered animal.

(*c*) Dog No. 45, adult pointer. Infested June 4th with forty males of Lot 6 ticks. No fever. Proved susceptible by inoculation in July with blood from a recovered animal.

(*d*) Dog 46, small yellow cur, adult. Infested June 5th with thirty males of Lot 6. No fever. Later proved susceptible by inoculation with blood from a sick dog.

(*e*) Dog No. 47, adult bull terrier. Infested June 18th with thirty adults of Lot 6. No fever. Proved susceptible in August by inoculation from the pointer off which the parents of Lot 4 ticks were taken.

A number of engorged nymphs of Lot 6 were sent to Dr. G. H. F. Nuttall, of Cambridge University, England, who kindly undertook to test the resulting adult ticks on dogs confined at his laboratory. As at the Cape, no case of fever resulted, which was greatly to my disapointment, since the object I had in view was to secure over-sea affirmation by a well known scientist that the disease was tick-transmitted. Before he reported his failures I had written as follows: "If failure results we will have evidence that not all the individual progeny of females fed on pathogenic blood are infective. This is what reasoning would lead one to expect, and what I believe is indicated by the results of inoculations with recovered blood. . . . Now the female tick takes up only a small amount of blood, and is it not reasonable to suppose that the infective matter therein is insufficient for the whole of the several thousand eggs which she has to lay? Perhaps only a very small proportion receive the organism, and it might easily happen that no infective ones be present in the twenty or thirty of the progeny we are finally able to test. In all my previous tests of pathogenic ticks, I have had progeny of females taken off dogs during the fever period, when, as we know from microscopic examination of the blood, the organisms are very abundant. This last time, the females were removed after a fever period. The blood of the animal at the time was very thin, and probably contained the organisms in small numbers only."

One failure was later experienced with Lot 4 ticks on Dog 63, as recorded under "4h" above. Two female

ticks certainly attached, and the dog later sickened when infested with more ticks of the same lot.

Still another failure was experienced when working with Lot 5 ticks which traced to a recovered dog.

Dog No. 65, small fox terrier, a young adult. Infested April 29th, 1903, with about seventy-five adults of Lot 5 ticks. Infestation repeated May 5th, but still not over eight ticks observed on the skin, only two of which, both males, known to date from first application. No fever to May 23rd, when animal destroyed because much affected with mange. Though not proved susceptible it probably was so as it was town bred and had been brought to the kennels when still a pup in January. It was a short, hard-haired animal and the ticks applied which failed to attach probably wandered off to dogs 72, 75 and 76, which were confined in the same room and were under the same test; all three had skins better adapted to the comfort and safety of ticks.

C. ADULT PROGENY OF DOG TICK FED DURING INCUBATION PERIOD OF DISEASE NON-PATHOGENIC.—The tests in this direction were few but decisive. The ticks used were all the progeny of females taken off Dog 6 on October 2nd and 3rd, two to three days before the said dog came into fever from the application of these very ticks, with a few others of the same history. However, as the progeny were fed on various dogs as larvæ and nymphs, they must be classed in several lots for discussion.

Lot 7 ticks, the progeny of females off Dog 6, October 2nd and 3rd. Fed a^8 larvæ on Dog 11, six weeks recovered, about December 1st, 1901, and a^8 nymphs on Dog 7, susceptible, about January 3rd.

Dog No. 15, young fox terrier. Infested February 4th, with eighteen Lot 7 adults. Biting very good and five of the females recovered after engorgement. No fever.

Lot 8 ticks, same parentage as 7 but fed as larvæ on Dog 12 about December 18th, when animal in full fever, and as nymphs on Dog 14, susceptible, January 2nd to 4th.

Dog No. 15. Infested February 17th, with twelve adults of Lot 8 ticks. Biting very good. No fever. Dog later proved susceptible by inoculation of 1 c.c. blood from No. 11 injected April 17th.

Lot 9 ticks, same parentage as 7 and 8 but fed as larvæ and nymphs on Dog 7 in health.

Dog No. 16, small mongrel pup. Infested January 27th with fifty adults of Lot 9 ticks. Biting good. No fever. Died in March as result of heavy inoculation.

D. NYMPHAL AND ADULT DOG TICKS FED IN PREVIOUS STAGE ON SICK OR RECOVERED DOGS NON-PATHOGENIC.—It will be observed that Lot 7 ticks, though fed as larvæ on a recently recovered dog, failed to infect the susceptible dogs upon which they were fed as nymphs and adults; also that Lot 8 ticks, though fed as larvæ on a

dog in full fever, failed to become pathogenic. These results must signify that the larva is as incapable of deriving infection that it can pass on for transmission by a later stage, as it is of transmitting infection that is in it by inheritance from the parent. Further evidence to the same effect, and also that the nymph is similarly innocuous, is afforded by a few other tests that were made.

Lot 10 ticks, the progeny of two females taken off Dog 7, November 2nd, 1901, when animal healthy and susceptible to malignant jaundice. Larvæ fed on Dog 12 in fever and dying, December 16th-19th.

Dog No. 14, adult fox terrier bitch. Infested heavily January 8th with Lot 10 nymphs. Eight recovered. No fever. Animal proved susceptible by inoculation from recovered Dog 11 one month later; it fevered and died.

Dog No. 16, small mongrel pup. Infested January 16th, with Lot 10 nymphs. Eight recovered engorged up to the 20th when animal washed to destroy balance, probably a score or more. No fever.

Lot 11 ticks, the progeny of Lot 9, and therefore positively non-pathogenic by inheritance. Parents off Dog 16, February 5th to 7th, 1902. Larvæ fed on healthy pup, March 17th to 20th. Nymphs fed on Dog 25, April 9th to 14th, just after fever had lapsed in the animal and a few days before its death.

Dog No. 43, adult fox terrier. Infested June 4th, with seventy-five Lot 11 adults. About ten only found to have attached. No fever resulted. Died July 15th from worms and debility.

Dog No. 44, adult fox terrier. Infested June 4th along with No. 43, and about same number found to attach. No fever. Animal killed by another dog on June 29th.

E. Adult Dog Ticks removed from Dogs dying of the Fever may or may not be pathogenic.—The tests here grouped prove very well that the tick is not a mere mechanical transmitter of the disease organism; and one is, therefore, led to presume that it is the true host of the organism just as the mosquito is the true host of the organism of human malaria.

1. Dog No. 7, fox terrier pup. Infested October 9th, 1901, with ten males taken off Dog 6 at its death on the same day. Five at least bit in and remained a fortnight. No fever. Animal later proved susceptible by inoculation of blood from recovered dog.
2. Dog No. 37, fox terrier adult. Infested July 26th, 1902, with about fifty males taken off dying pointer (source of Lot 4 ticks). Biting good. No fever. Susceptibility proved by reaction to inoculation of 1 c.c. blood from Dog 11 recovered.
3. Dog No. 42, small fox terrier adult. Infested July 26th, 1902, with about fifty males taken off dying pointer. Biting good. No fever. Later proved susceptible by inoculation of virulent blood.
4. Dog No. 46, small yellow cur pup. Infested July 25th, 1902, with about fifty males taken off dying pointer. Biting good. No fever. Later proved susceptible by inoculation of virulent blood.
5. Dog No. 70, small fox terrier adult. Infested February 9th, 1903, with twenty males of Lot 4 ticks off 66 when dying. Infested February 14th with thirty-five more of same lot but off 67 dying. A few known to have bitten and remained. Fever appeared February 24th; death with typical appearances, March 4th.

The source of the infection transmitted to Dog 70 is presumed to have been not the feeding on Dogs 66 or 67, but the feeding of the mother ticks on the pointer. In other words, it is supposed that some one or more of the ticks applied had not exhausted the supply of inherited infection in infecting 66 or 67; and that, incidental to attaching to the new dog, some of this old store was injected.

F. JACKAL NATURALLY IMMUNE TO THE DISEASE.—A natural desire of long standing to test the susceptibility of a jackal to the disease was gratified in January of this year, through the kindness of Mr. Robertson in placing at my service a young red jackal that had come into his possession.

Jackal. Infested January 30th, 1903, with about two hundred adults of Lot 4. Biting very good and nearly a hundred engorged females secured eight to fourteen days later. Temperature taken daily but no fever readings recorded.

Not being certain that the animal had not had the disease early in life, I had Mr. Robertson inoculate it with virulent blood on February 21st, and on March 4th inoculate 8 c.c. from it into a susceptible dog, No. 76. The dog did not react, and, as when it was later exposed to pathogenic ticks, it sickened and died, it is clear that the jackal was quite immune.

G. TESTS WITH OTHER KINDS OF TICKS, AND FLEAS.—The following tests supplied further evidence that the transmission of the disease by ticks is not a mere mechanical transference of the causal organism from one dog to another, as in inoculation with blood.

Bont Tick (*Amblyomma hebraeum*). Larvæ fed on Dog 14, February 13th to 18th, 1902, when animal in high fever. As nymphs about one hundred and fifty placed on Dog 21. Biting very good, but all except a few scratched off before engorgement. No fever reaction.

Tampan Tick (*Ornithodoros savignyi*). Nymphs and adults fed November 14th, 1901, on Dog 10 when it was dying in fever. After moulting, five fed on Dog 22, February 17th. No fever reaction.

Another lot fed February 18th, 1902, on Dog 14 when it was in high fever. After moulting, about fifteen fed on Dog 42, July 1st. No fever reaction. More of same lot applied to Dog 46, September 18th. No fever reaction.

Fleas (*Pulex serraticeps*). Dog 7 infested December 17th, 1901, with five females and three males taken from Dog 12 in fever, and seventeen females and six males from Dog 11 recovered. The fleas bit in very well, but no fever resulted.

Reared adult fleas from eggs dropped by females on Dog 9 at height of fever, December 1st, 1901, and Dog 11 recovered on same date. Exposed Dog 16, a young pup, to attack by these reared fleas, twelve tracing to Dog 9 and thirty to Dog 11, on January 4th. Fleas bit well. Both this Dog and No. 7 had been thoroughly washed and isolated a few days before the fleas were applied and were seen to be clean of other fleas when the tests were started. Dog 16 transferred January 11th to a room that had previously been occupied for several months solely by recovered Dog 11, and which was swarming with fleas. No. 16 became very badly infested and remained so until washed again on January 20th, but it did not contract the disease.

The transference of lice from sick dogs to healthy ones was not attempted, but on three occasions when very lousy dogs were used in inoculation experiments, clean susceptible dogs were confined in the stalls with them after the fever appeared. The new dogs became much infested with lice without contracting the disease.

During the coming year, if more important work does not interfere, it is proposed to determine if the progeny of *Haemaphysalis leachi* ticks off sick dogs will prove pathogenic when adults, if they are fed on a cat when larva or nymph. And it is further planned to test adult progeny of *Ixodes pilosus* ticks off sick dogs.

APPENDIX.

PROCLAMATION

BY HIS EXCELLENCY THE HONOURABLE SIR WALTER FRANCIS HELY-HUTCHINSON,

Knight Grand Cross of the Most Distinguished Order of St. Michael and St. George, Governor and Commander-in-Chief of His Majesty's Colony of the Cape of Good Hope, and of the Territories and Dependencies thereof, etc., etc., etc.

UNDER and by virtue of the powers and authorities vested in me by Act No. 9 of 1876, entitled "Act to Regulate the introduction into this Colony of articles or things which by reason of disease or otherwise might be injurious to the interests thereof," I do hereby proclaim, declare, and make known that I have made the Regulations set forth in the Schedule hereto for preventing and regulating the introduction into this Colony, by sea, from beyond the boundaries thereof, of the articles and things specified in the said Regulations.

Any person or persons contravening any of these said Regulations shall, on conviction, be liable to a fine not exceeding £100 sterling, and in default of payment thereof shall be liable to imprisonment for any term not exceeding six months, unless such fine be sooner paid:

And, under and by virtue of the powers and authorities vested in me by the aforesaid Act and by the Vineyards Protection Act, 1886, I do hereby further proclaim, declare, and make known that Proclamations No. 107, bearing date the 25th day of March, 1896, and No. 475, bearing date the 10th day of November, 1897, and all Regulations prior thereto issued in this behalf, are from this date cancelled, revoked and made void.

GOD SAVE THE KING!

Given under my hand and the Public Seal of the Colony of the Cape of Good Hope, this 20th day of March, 1903.

WALTER HELY-HUTCHINSON,
Governor.

By Command of His Excellency the Governor in Council.

JOHN FROST.

No. 96, 1903.

SCHEDULE TO FOREGOING PROCLAMATION.

IMPORT REGULATIONS.

1. The introduction into this Colony of trees, plants and portions thereof—such as cuttings, roots, tubers and bulbs—and of fruit of all kinds, grown elsewhere than in South Africa is prohibited, save and except by sea through the Ports of the Colony or by Post.

2. The importation of the following articles is hereby absolutely prohibited:—

(*a*) Grape vines or any portion or fruit of any grape vine, with the exception of vines or portions thereof imported by the Government under such precautionary measures as it may deem necessary.
(*b*) Coffee plants or any portion thereof, with the exception of seed.
(*c*) Eucalypt plants or any portion thereof, with the exception of seed.
(*d*) Stone-fruit trees or any portion thereof, including seeds, that were grown or produced in any state, province or territory of the United States of America or the Dominion of Canada, in which either of the diseases known as Peach Yellows or Peach Rosette exists.
(*e*) From and after the 1st day of January, 1904, peach stocks and peach stones from any country whatsoever.

3. From and after the 1st day of January, 1904, the importation of any fruit-tree or portion thereof, with the exception of fruit, seed, seedling stocks for budding or grafting purposes, and blight proof stocks for apples, shall be allowed only by special permission from the Minister for Agriculture. No permit shall be granted for the introduction of more than ten trees or one hundred cuttings of any one variety, nor shall permits be issued for more than an aggregate of one hundred trees or one thousand cuttings to any party during one year.

4. All trees, plants and portions thereof—such as cuttings, roots, tubers and bulbs—and fruit of all kinds, and their packages, cases, pots or other coverings, shall, before being delivered to the consignees, undergo an examination by an officer appointed for that purpose to determine, as far as possible, whether or not insects or plant diseases are present; and it shall be the duty of the consignee or his duly appointed agent to open the coverings and to afford every facility to the Examining Officer during the examination.

5. All trees and woody plants, together with their covering and packing material, shall, as a precautionary measure against the introduction of injurious insects, be fumigated at the expense of the consignee in the manner prescribed by and to the satisfaction of the Examining Officer; and if the Examining Officer deems the treatment expedient he may extend it to all other plants and all parts thereof.

6. Should any article, in the examination provided for in Clause 4, be actually found to be infested in whole or in part with any insect or plant disease the introduction of which would be prejudicial to the interests of the Colony, it shall, together with all other articles in the same receptacle with all covering and packing material, be cleansed or disinfected by the consignee. or at his expense, in the manner prescribed by and to the satisfaction of the Examining Officer; and if not so cleansed or disinfected, or if any treatment at command shall be deemed by the Examining Officer, or found by him, to be inefficient for the absolute eradication of the insect or disease, or if the Examining Officer knows the insect or disease to be of specially dangerous character, the articles shall be destroyed without delay.

7. Ordinarily. the inspection, and other treatment of consignments imposed by these Regulations shall take place on the premises provided for the purpose by the Government at the port of entry; but special arrangements may be made with the Minister for Agriculture for the execution of all the provisions of Clauses 4, 5 and 6 on the premises of the consignee, when approved facilities, inclusive of a proper fumigation chamber, are there provided.

8. On the Examining Officer being satisfied with respect to a consignment that all the regulations and conditions herein set forth have been fully complied with, he shall issue a certificate to that effect to the consignee; and before the issue of such certificate the consignment shall be under his control for the purposes of these regulations.

9 Articles subject to examination under these regulations introduced into this Colony by post shall be intercepted and examined by an officer appointed for the purpose; and if found affected with any noxious insect or plant disease shall be destroyed or cleansed at the discretion of such Examining Officer, and if requiring fumigation shall be so treated. All expenses of treatment shall be borne by the addressee.

10 The Government does not hold itself responsible for any loss or damage that may result from the destruction of articles under these Regulations, or from any process that may be considered necessary to cleanse or disinfect the articles, or to discover the existence or otherwise of any insect or plant disease.

11. These Regulations shall not apply to any consignment imported *in bond* for places beyond the borders of the Colony; nor to canned, dried or otherwise preserved articles in which there is no longer any plant life.

ANIMAL DISEASES EXPERIMENT STATION.

Exterior view with laboratory in foreground, views within the court.

UNIV.
CALIFORNIA

CAPE OF GOOD HOPE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

Half-Year ended June 30th, 1904.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

Half-Year ended June 30th, 1904.

Presented to both Houses of Parliament by command of His Excellency the Governor.

CAPE TOWN:
CAPE TIMES LTD., GOVERNMENT PRINTERS. KEEROM ST.

1905.

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Cape Town, 20th December, 1904.

THE HONOURABLE THE SECRETARY FOR AGRICULTURE.

SIR,—I have the honour to present herewith my report for the period January 1st to June 30th, 1904, together with the report of the Assistant Entomologist (since given the title Eastern Province Entomologist), and a few special reports on the progress of investigations.

CHAS. P. LOUNSBURY, B.Sc., F.E.S.,
Government Entomologist.

TABLE OF CONTENTS.

PAGE

GENERAL STATEMENT 1

Staff of Branch.

Appointment of Eastern Province Entomologist.

Publications 2

Articles in Agricultural Journal.

Plant Import Regulations 3

New Schedule.

Inspection of Post Office Parcels.

Nursery Legislation 3

Bill again introduced but not acted upon.

Modified Draft prepared.

Ticks and Animal Diseases 4

Co-operation with Veterinary Department.

African Coast Fever 4

Transmission by Brown Tick.

Inconsistent Results.

Infection not secured from Recovered Animals.

Progeny of Blue Tick innocuous.

Progeny of Brown Tick innocuous.

Continuation of Investigations.

Heartwater 7

Progress of Investigations.

Locusts 7

Red Winged Locust in Coast Districts.

New Invasion of Inland Districts by Brown Locust.

May Locust eggs retain Vitality for Period of years?

Work of Eastern Province Entomologist 9

Investigation of Mealie Pests.

SPECIAL REPORTS.

SPECIAL REPORTS OF GOVERNMENT ENTOMOLOGIST 10

Ticks and African Coast Fever 10

Detailed Data of Infections.

Perplexing Features of Cases produced in Experiments.

Temperature Records of Animals infested.

PAGE

Heartwater Investigations 15

Cattle are subject to Heartwater.

Variance in Degree of Virulence.

Horses are Immune to Heartwater.

Seemingly conclusive Test.

The Blue Tick is non-pathogenic.

Results consistent with earlier work.

Death from Tick Irritation.

Persian Sheep and Heartwater.

The Animals Susceptible to the Disease.

Remarkable Resistance.

Diagrams illustrating Transmission of Infection.

REPORT OF ASSISTANT ENTOMOLOGIST, INCLUDING SPECIAL REPORTS... 26

Insects affecting Mealies 26

Mealie Stalk Borer.

Life History and Habit Notes.

Remedies suggested.

Late Planting Objectionable.

Influence of Natural Enemies.

Cutworms or "Black Grubs" 30

Insects affecting Fruit 31

Fruit Moths 31

Thirteen different Kinds.

Fruit Fly 31

Inefficient Parasite discovered.

APPENDIX.

Statement of Plant and Fruit Imports for Half Year.

Revised Plant Import Regulations Proclamation.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Half-Year ended 30th June, 1904.

Presented to both Houses of Parliament by command of His Excellency the Governor.

Only six months, January 1st to June 30th, are covered by this report, and future reports are to cover the financial year, July 1st to June 30th, instead of the calendar year as heretofore. The Branch Staff on June 30th was as recorded in the last report: namely, the Government Entomologist, Assistant Entomologist and Assistant to Entomologist. Funds were provided by Parliament during the last session for an Entomologist for the eastern districts and the Assistant Entomologist, Mr. C. W. Mally, M.Sc., has been appointed to the post with the title "Eastern Province Entomologist." His permanent headquarters are at Grahamstown where, for the financial year 1903-1904, he was temporarily stationed. No one has yet been appointed to the vacated post of Assistant Entomologist, and at the time of writing no effort to secure anyone is being made owing in part to the depressed financial condition of the Government and in

part to other considerations. However, a man for the post is much needed, as routine matters now take up so much of my time that less research and field work is being done than in past years. It is also urgent that provision be made for an office assistant for the Eastern Province Entomologist; at present there is no one to give attention to office and laboratory matters when he is absent on field investigations.

In late February I represented the Department at the annual meeting of the Central Farmers' Association held in Grahamstown. And immediately thereafter I spent three weeks touring eastern districts on various official matters. The Examiners of Plant Imports at Port Elizabeth and East London, officers now under my supervision, were visited, and their duties discussed with them. An ordinary meeting of the Kei Road Farmers' Association, and a specially called meeting of Chalumna farmers were attended, and timely information given concerning African Coast Fever and tick investigations. Uitenhage, Fort Beaufort, Komgha and Fort Cunynghame were visited, the latter place in company with District Forest Officer Sim to determine the present standing of the Oak Phylloxera. During early April a few days were spent at Pretoria attending the first conference of South African official horticulturists and entomologists. The chief object of the conference was to discuss horticultural legislation with the view of securing practical uniformity in the regulations which were or might be brought forward in the different colonies. A resolution in support of the proposed Cape Import Regulations, since gazetted, was carried unanimously. The only other absences from office were taken for trips of a few days' duration at the most to areas south of the Hex River mountains, and were for purposes of investigation or observation.

PUBLICATIONS.—The only contributions to the *Agricultural Journal* of importance were: an eight page article entitled "The Nurseries Inspection and Quarantine Bill" in the February issue, a four page one entitled "Transmission of African Coast Fever" in the April issue, and a five page one entitled "Revised

Plant Import Regulations" in the June issue; the second was illustrated by three full-page plates,—one of them in colours.

PLANT IMPORT REGULATIONS.—The schedule to the regulations affecting the introduction of trees, plants, fruits, etc., from oversea was further amended in May. The regulations are carried out under my direction, and no effort is spared to render them effective. I consider them of inestimable value in protecting the Colony from the insect pests and plant diseases of other lands. The introduction of some kinds of trees is totally prohibited, and only a limited number of *any* kind may be imported, and these only under special permission. In the appendix will be found a copy of the schedule and a statement of the quantities of the different articles passed by the Examiners. As has for several years been the custom, imports of plants through Cape Town are inspected by myself or an assistant; and since the location of the Assistant Entomologist at Grahamstown, consignments to the nurseries situated in that section have been inspected by him. Articles affected by the regulations introduced by post are examined, and, if necessary, fumigated at my office. One hundred and seventy-one parcels were detained for examination during the six months. Until recently there was no provision for the collection of fumigation fees, but now, through the courtesy of the Post Office Management, the charges imposed for the service are collected from the addressee by the delivering post office, and paid into general revenue.

NURSERY LEGISLATION.—The "Nursery Inspection and Quarantine Bill," which I helped to draft, and the passage of which I have urged for a number of years in my reports, was introduced into Parliament again this year, and once again the House was prorogued without its getting a second reading. A great deal of my time has been given in vain to this Bill year after year, and meanwhile the dissemination of insect pests with nursery stock has steadily gone on. Satisfied that there is little chance of the measure

becoming law in its present form, I have had it redrafted and hope to have it introduced and accepted during the coming session.

TICKS AND ANIMAL DISEASES.—A leading feature of the work of the Branch has been a continuance of the investigations to elucidate the association of ticks with animal diseases. Such work has taken much of my own time, and practically all that of the Assistant to Entomologist, Mr. R. W. Jack. For the general good of the work, the Veterinary Branch and my own pursue these investigations conjointly. The rearing and the care of the ticks and the planning and conduct of all experiments with them is done by me or my assistant; whilst the procural and the general care of the animals for experiments, all innoculations, bacteriological study of blood smears, and *post-mortem* examinations are left to the attention or supervision of the Veterinary Branch, chiefly to Mr. Wm. Robertson, its Bacteriologist. I have to thank Mr. D. Hutcheon, the Chief Veterinary Surgeon, for his never failing interest and invaluable assistance in the work. Every matter of importance in connection with the experiments has been discussed with him,and to him personally is due much of the credit for what success has been achieved. The experiments are conducted in the specially constructed premises in the suburbs, about four miles from Cape Town, but within a hundred yards of the Rosebank railway station.

AFRICAN COAST FEVER.—The results of our experiments have conclusively shown that the Brown Tick (*Rhipicephalus appendiculatus* Neumann) is capable of imbibing the infection of African Coast Fever in its nymph stage (the second of its three life stages) and of transmitting this infection in the following or adult stage of the same life cycle; also that both sexes of the tick may transmit the infection, and that one or two specimens of the tick are quite enough. These conclusions are based upon seven cases of the disease that were produced during the first four months of the year by adult ticks which as nymphs had been fed on a sick cow near Bulawayo in December. The

parents of the particular ticks came from East London cattle, so there is no doubt at all that we have the proper tick to spread the disease in the Colony. The species occurs all along our eastern and southern coast and some distance inland.

For some still undetermined reason, numerous tests of nymphs and adults of the Brown Tick taken, as larvæ and nymphs respectively, from the cases produced at our Experiment Station by the ticks fed at Bulawayo, have failed to give positive results. These disappointing and perplexing failures have nullified the value of numerous tests of other kinds of ticks fed on the same sick cattle. The results of all these tests have been negative. Lest some one may be led to think from these statements that there is a chance that the disease will not spread at the Cape should it be introduced, it is advisable to encroach on the work of the new year by mentioning that in July we had one good case produced by nymphs fed as larvæ on one of our earlier cases; and further that still later we have had a single case produced by adults that as nymphs fed on the July case! All the cattle used were locally bred and presumably susceptible, when they came to us, to Redwater and Heartwater. But the presence or absence of immunity to these other diseases, either in those tested or in the sick ones on which the feeding of the ticks to be tested was carried out, does not appear to be correlated with the failures; some of both groups of animals had salted to Heartwater or had been inoculated with freshly drawn blood from cattle immune to Redwater before being used for the Coast Fever experiments.

Two cattle that had recovered from African Coast Fever some months before were kindly given to us during the winter of 1903 by the Transvaal Government. One of these came direct from highly infected veld, the other from veld near Pretoria that may or may not have been infected. Large numbers of Brown Tick nymphs have been fed on these animals and afterwards as adults have been tested on susceptible cattle: in no case has infection resulted. Most of the tests were made between November, 1903, and Janu-

ary, 1904, that is in hot weather. To affirm that it actually was an immune animal, one of the Transvaal cattle was infected with pathogenic ticks of the lot that produced the seven cases; twenty-three specimens were applied and though all attached no reaction followed.

Failure to infect has been the outcome of the tests of the progeny of the different lots of the blue Tick (*Rhipicephalus decoloratus*) received from veterinary surgeons or personally collected from sick cattle in the Transvaal and Rhodesia; and also of the progeny of eight different lots of the Brown Tick similarly procured. Many hundreds of each of the lots of the Blue Tick matured. It was thought probable for a while that the Brown Tick progeny though innocuous as larvæ and nymphs would prove pathogenic as adults, our experiments with the Dog Tick having demonstrated that adult progeny of females off Malignant Jaundice dogs are pathogenic. The Brown Tick (like the Dog Tick) drops from its host to undergo its transformation from larva to nymph and from nymph to adult, and thus it ordinarily feeds on three different animals in the course of its life cycle. It follows that if adults may transmit infection derived from the previous generation, the infection might be easily brought into clean areas by healthy cattle and perhaps by other kinds of animals on which the intermediate stages of the tick may feed. It is very satisfactory, therefore, that the experiments with adult progeny of Brown Tick females off sick cattle have given uniformly negative results. Very fair tests with three lots of such adult progeny were carried out. The mother ticks of one lot came from dead and dying cattle at Nelspruit in the Transvaal, and of the other lots from dead and dying cattle in Rhodesia; they were removed by me personally, and the assumption that the cattle had the particular disease was borne out by bacteriological examination of the blood and by the lesions found after death.

Tick experiments with African Coast Fever are being continued. The objects in view are: 1, to as-

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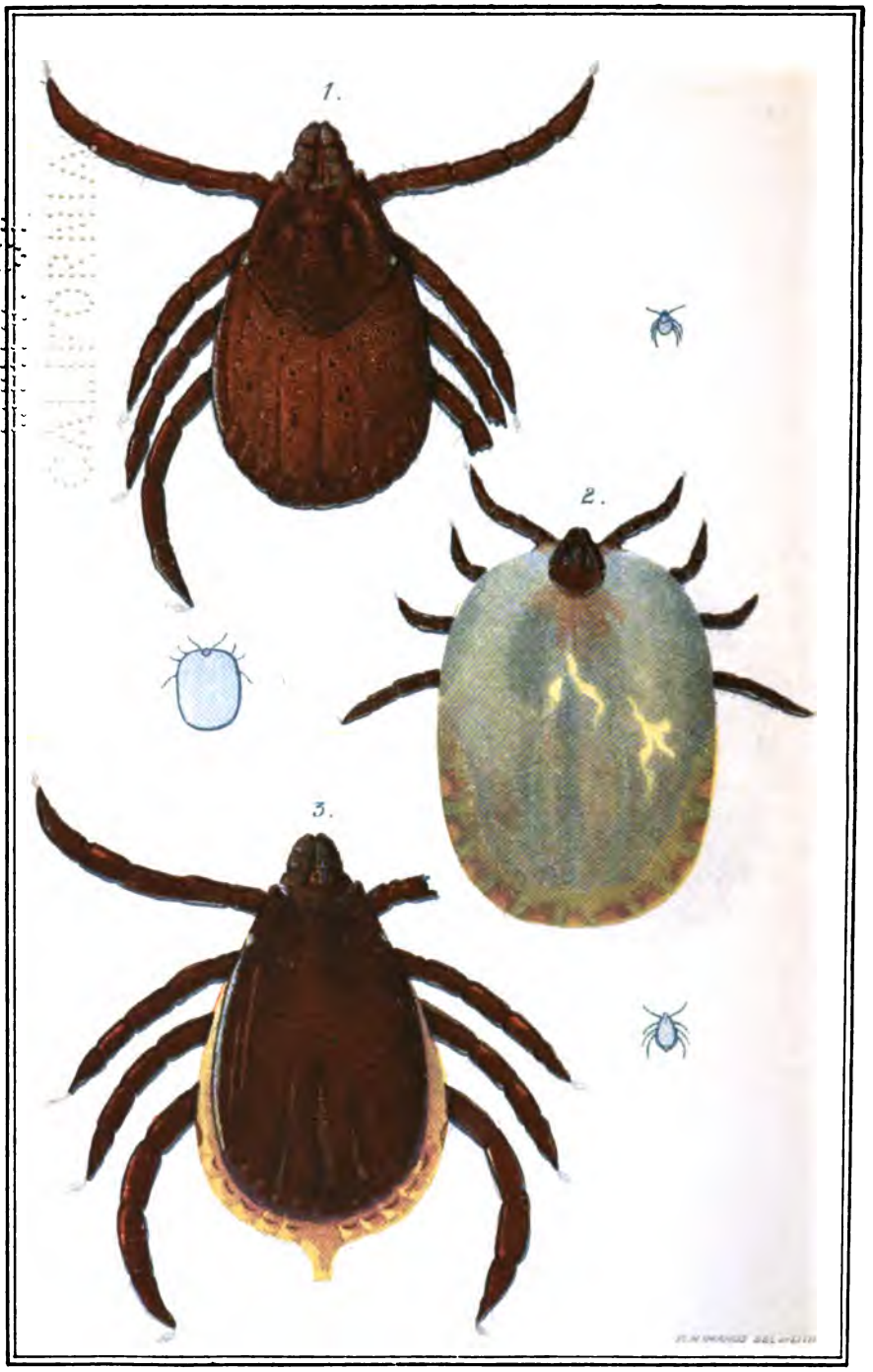
THE BROWN TICK.

(Rhipicephalus appendiculatus).



1. Female, before feeding—twelve times natural size. 2. Female, after feeding—four times natural size. 3. Male, after feeding—twelve times natural size

The outline figures show the natural sizes.

certain the factors which have led to the failures to propagate the disease from the cases experimentally produced, in the hope that the knowledge may throw new and important light on the natural transmission of the infection; 2, to ascertain if ticks fed in the first or larval stage on sick cattle may transmit the disease when they become adult if in the intervening stage they are fed on non-infected animals; and 3, to determine if the Red Tick (*Rhipicephalus evertsi*), the Capensis Tick (*R. capensis*) and other ticks that are more common or more widely distributed than the Brown Tick may transmit the disease.

The detailed data in regard to the seven cases of the disease produced during the period January 1st to June 30th is given under a special heading in the second portion of this report. The plate herewith, republished from the *Agricultural Journal*, shows the characters of the Brown Tick. The depth of colour on the body of the full fed female tick is not correct; it should be much darker.

HEARTWATER.—To the information published in previous reports concerning the transmission of Heartwater, I have to add that the past year's experiments have affirmed the findings that cattle and Persian sheep are subject to this disease, that horses are not subject to it, and that the ordinary Blue Tick (*Rhipicephalus decoloratus*) is not a factor in the transmission of infection. Further, there is to add that while Persian sheep have been found by the experiments to be quite susceptible to the disease they have proved to take it in a mild form only; and, nevertheless, that infection derived from them has proved quite as virulent as infection from animals fatally affected.

The data in regard to the experiments is given in the second portion of the report.

LOCUSTS.—The Red Winged Locust (*Acridium purpuriferum*) continues troublesome along the coast from about the Kowie mouth eastward to Natal. It is full time the Cape had legislation to compel owners and occupiers to deal with the swarms that hatch on their lands, and I have recommended that a Bill on

the lines of the Act now in force in Natal be brought before Parliament.

The Brown Locust (*Pachytylus sulcicollis = capensis*), which has been more or less in evidence in the Karroo districts continually for thirteen years, threatens to be more abundant in the coming season than since the first years of the invasion. During March and April large but not dense swarms moved eastward and southward from the northern border districts over the southern half of the Orange River Colony and our eastern and midland districts as far east as St. Marks, south as Fort Beaufort, and west as Beaufort West. Eggs were deposited in most of the districts invaded. The swarms appear to have originated in Griqualand West, the movement having been outward from that part of the Colony. It is quite possible, however, that some swarms came down from the Kalihari. Mr. W. H. Wayland of Fort Richmond, in Herbert District, under date of June 1st, wrote:

> "The locusts which are now appearing in the Colony and Orange River Colony were hatched in a belt of country about thirty miles wide extending from Belmont westward, a tract which has had very little rain this season. A curious feature of this visitation is that we do not know when the eggs were deposited, we not having had locusts depositing here for several years. Another curious feature is that the eggs did not hatch after the first rainfall, on January 10th last. Eggs laid in the autumn usually hatch after the first rain in spring. This season we had twenty-four hours' rain on January 10th, but the eggs did not hatch until after a shower, which fell in February. Then, after those coming out in February had taken wing, a second crop of young ones hatched out about the end of March."

This letter is inserted here to get it permanently recorded. That locust eggs may hatch after being in the soil for several years is a proposition that few zoologists would entertain, but I confess that I no longer think it impossible, and incline to believe there is a basis of fact to the common notion that voetgangers have often appeared in localities not visited by winged locusts for ten years or more. It may be that under certain conditions the eggs on being extruded are enveloped in a substance that retards desiccation and the absorption of water by them much more than the secretion which is used to line and cap the egg cells ordinarily made. Mr. Stewart Stockman records the

deposition of eggs embedded in a firm, hard, secretion by immature unfledged females of a species of *Acridium* in India (Agricultural Ledger, No. 3,1903; Ent. Ser. No. 10); these egg-masses are evidently designed to resist the desiccating influence of the dry season, which season intervenes before the mature locusts deposit egg-masses of the ordinary type. If eggs of our ordinary locust do sometimes remain alive but unhatched for a period of years, it may be this feature of the creature's economy that is responsible for the sudden appearance of vast swarms. The parasitic and predaceous enemies would practically disappear during the protracted sleep of the pest, and thus there would be insufficient means to prevent the development to maturity of the myriads that might hatch. The length of time during which locust eggs will retain their vitality has not been experimentally tested, so far as I am aware. Through the kindness of a number of farmers resident in the districts invaded this season, I have now in my possession a large quantity of eggs, and plan to make such a test with them; from time to time moisture will be supplied to small numbers.

WORK OF EASTERN PROVINCE ENTOMOLOGIST.—The Eastern Province Entomologist (Assistant Entomologist during the period covered by this report) works under my general supervision. He is directed specially to investigate the insect pests of the mealie plant (*Zea mays*), the Fruit Fly (*Ceratitis capitata*), and the fruit sucking moths. These subjects have had his attention for the greater part of the year, and special reports by him to show the progress which he has made appear on later pages. His study on the Mealie Stalk Borer (*Sesamia fusca*) has been his most important work, and his report on that insect is of special interest and value. He believes it can be controlled by clearing the stalks from the land soon after the harvest, and of so disposing of them that the insects harbouring therein are destroyed; that they be silaged or shredded for fodder is his practical suggestion.

CHAS. P. LOUNSBURY, B.Sc., F E.S.,
Government Entomologist.

SPECIAL REPORTS.

BY THE GOVERNMENT ENTOMOLOGIST.

TICKS AND AFRICAN COAST FEVER.

The following are the details of the infection of the seven cattle stated in the body of the report to have suffered African Coast Fever (Piroplasmosis caused by *Piroplasma parvum* of Theiler) at the Animal Diseases Experiment Station, Rosebank, during the period under review. The ticks used were adults of the Brown Tick (*Rhipicephalus appendiculatus* Neumann), and were all of one history. As nymphs they had been fed by me on a sick cow at Bulawayo in early December, 1903. As larvæ they had fed on a healthy bull at the Experiment Station; and they were the progeny of females taken from an animal in the East London district of the Colony. A large number of specimens of the same parentage was reared on the same animal as larvæ, but on healthy Cape cattle during the two remaining feeding stages; and the fact that these specimens quite failed to affect the health of the animals shows that the infection, transmitted by the particular specimens that fed on the sick Bulawayo cow was due to the nymphal feeding.

1. Ox 17. A Cape bred bull about two years old. Not known to have had any disease. Ear infested January 3rd, 1904, with fourteen specimens. Six attached and two females fed to repletion. Fever set in January 16th, and terminated with death on the 22nd.

   Mr. Robertson was unable to demonstrate the existence of organisms in blood smears taken before January 21st, and only small numbers of spherical ones were then found. The *post mortem* lesions were typical. The lungs were oedematous and the intestines much inflamed; there was enlargement of the lymphatic glands and whitish infarcts in one of the kidneys. Inoculations into other cattle and goats were without effect.

2. Ox 3. A Cape bred bull about two years old. Had heartwater under observation in 1902, but not known to have had any other disease. Ear infested January 5th with twelve specimens. Nine attached and two females fed to repletion. Fever appeared January 21st and terminated fatally on the 31st.

   Mr. Robertson could find no parasites in the blood until the day of death when small numbers of both rod and spherical ones were located. The *post mortem* examination revealed typical

lesions. There was froth in the trachea, slight oedema of the lungs, severe fourth stomach and intestinal lesions, great swelling of lymphatics, particularly under jaw, and an immense number of white and red infarcts in the kidneys.

3. Ox 24. A Cape bred bull about two years old. Had been inoculated periodically for several months from a Transvaal ox that had come through African Coast Fever, and which was doubtless salted to Redwater; a temperature reaction attributed to Redwater had been given. Not suspected to have had any other disease.

Ear infested January 12th with 12 specimens. Nine attached, but no fed females recovered. Fever set in January 24th and terminated in death on February 5th.

Blood parasites were not found in any smears taken before February 2nd, three days before death. Then and later a few of both rod and pyriform bodies were observed. The usual lesions of African Coast Fever were found at death, the lungs being very oedematous, the fourth stomach and intestinal tract much congested, and the kidneys studded with infarcts. There was no appearance of a Redwater complication.

4. Ox 5. A Cape bred heifer, about two years old. Had heartwater under observation in 1902, and in December, 1903, had given a mild temperature reaction, without appearance of parasites, so far as could be detected by Mr. Robertson, to an inoculation from Transvaal ox from Komatipoort; the reaction suspected to have been Redwater. Ear infested January 26th with one male and one female of the ticks; both attached. Fever appeared February 11th, and death occurred February 25th.

In this case Mr. Robertson was able to find parasites in increasing numbers from the fifth day of fever, February 15th; rod and spherical forms were seen. About 70 per cent. of the corpuscles were invaded at death. The lungs were almost normal in appearance after death, but the intestinal tract and fourth stomach were inflamed and the kidneys much spotted with infarcts.

5. Ox 16. An Aged Cape cow. Had had heartwater under observation in 1903, but not suspected to have had any other infectious disease. Ear infested January 26th with one female tick. It attached and some days later was removed and destroyed. Fever appeared February 8th and continued until the 17th. The animal at no time appeared to be very ill, eating and drinking almost as freely as usual every day, and is still alive.

Rod and spherical organisms in very small numbers were found by Mr. Robertson in smears taken February 15th, and for a few days thereafter, but none were found after a week.

6. Ox 11. A Cape bred ox, aged about two and a half years. Had heartwater under observation in July, 1903, and gave reaction when inoculated in October from Transvaal ox recovered from African Coast Fever and presumably Redwater. Ear infested January 26th with a single male tick. This tick escaped, and is supposed not to have anywhere attached; if it attached, it failed to infect.

Ear infested March 11th with three males and two females. All attached. Fever set in March 23rd and death occurred April 4th.

Data relative to examination of blood smears lost, but it is recalled that organisms not found until late in course of fever, and that some were present on April 2nd. The *post mortem* examination disclosed the usual lesions of African Coast Fever and with no admixture of Redwater. The lungs were very oedematous and the intestinal tract much congested; the kidney infarcts were distinct, but not numerous.

7. Ox 29. A Cape bred bull about eighteen months old. Supposed not to have had any infectious disease ; yet in late February and again in early March had suspicious courses of high temperature. These each lasted about six days, and the first began twelve days after an application of Red Tick larvae from Rhodesian parent ticks : the highest morning temperature was 103° and the highest evening, 104°.

Ear infested March 28th with seven males. Five attached. Fever set in April 9th and terminated fatally on the 26th.

Piroplasma of the ordinary forms of the disease were found not uncommon and in constantly increasing numbers from April 19th. The *post mortem* examination disclosed many of the usual lesions, but the lungs were almost normal. The kidneys were studded with infarcts. Contrary to the usual experience the spleen was enlarged and similar to that of a Redwater case, and the bile was dark green and of consistency of thin tar.

Precautionary inoculations from each one of the seven cases into one or more cattle and two sheep or goats were made, and in no case did any infection appear to take place as a result. Red urine was not a feature of any of the cases. No reason has been assigned to the scarcity of parasites in the blood of the earlier cases. It is impossible that the staining reagents used were at fault since from time to time smears of blood known to contain the organisms were stained simultaneously as a control measure and in all these cases the bodies were clearly differentiated. However it is not desirable that this matter nor that of the lesions at death be discussed here, they being veterinary subjects. I merely wish to make mention of the facts because of their bearings on my work. The accompanying table gives the temperature record of each of the seven cattle infected from the date of applying the ticks.

Over a score of tests of Brown Tick specimens that were recovered from Nos. 17, 3, 24, and 11 late in the course of fever or after death, and from No. 16 between one and two weeks after the lapse of the fever have all resulted negatively. So have also one of two tests with nymphs that fed as larvæ, and two tests with adults that fed as nymphs, which fell on the tenth day of fever or later from No. 29. In nearly all cases the ticks tested transformed in the incubator or were warmed for three or more days therein before they were applied; and hence insufficiency of heat to develop infection within the ticks is not suspected as

the reason for the failures. It is likely that they are associated with the scarcity of parasites in the blood, but even accepting that the parasites must be numerous for the blood to be infective through the agency of the tick, a few of the failures would still remain unexplained—organisms being abundant when the ticks which were used were feeding; and the problem of why the organisms were not abundant would remain unsolved. One test of nymphs from No. 29, made since July 1st, resulted positively; and a test of adults from this case has also given the disease. The discussion of these cases is postponed for the next report.

[G. 6?—1904.]

AFRICAN COAST FEVER.—Infections by Adult Brown Ticks (*Rhipicephalus appendiculatus*).

Days from Infection.	Ox 17.		Ox 3.		Ox 24.		Ox 5.		Ox 16.		Ox 11.		Ox 29.	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
		101·8		103·0		102·6		104·2		102·2		102·0		101·6
1	100·0	101·0	101·6	102·0	101·6	102·6	102·0	102·2	101·0	101·4	100·2	102·0	102·0	102·4
2	100·2	102·2	102·0	101·6	101·6	103·4	101·4	102·4	100·2	101·0	101·0	102·6	100·6	102·2
3	101·0	103·0	102·2	102·6	102·8	102·0	102·4	101·8	99·8	101·0	101·0	101·6	101·6	102·0
4	102·2	101·8	102·0	102·4	102·0	103·0	101·6	102·0	101·2	101·0	101·0	102·6	102·0	102·0
5	101·6	101·6	102·2	101·4	102·4	102·8	101·6	102·2	100·0	101·4	101·4	102·0	101·0	102·0
6	102·2	103·4	101·0	101·6	102·0	103·8	102·0	104·6	100·0	101·2	101·0	101·6	102·2	101·0
7	101·0	102·0	101·0	100·6	101·6	104·0	103·0	105·6	101·0	102·0	100·4	101·0	102·0	102·0
8	100·6	102·0	92·2	101·0	102·2	101·6	102·8	103·6	101·4	101·6	101·0	102·0	101·0	101·6
9	100·6	100·2	101·6	102·0	102·0	102·2	102·0	103·6	100·6	103·4	101·0	101·2	101·0	102·4
10	100·4	101·6	101·8	101·6	100·8	103·0	102·8	103·8	101·6	102·2	99·4	102·6	101·8	101·2
11	101·8	101·8	101·8	102·0	100·6	-	102·2	101·6	101·0	101·6	102·0	102·0	102·2	103·2
12	101·8	101·6	101·2	102·2	104·8	105·4	101·4	101·0	101·8	101·6	100·6	101·8	105·0	104·2
13	103·6	104·6	102·0	101·8	105·2	106·0	101·0	102·2	102·2	104·0	102·0	103·6	104·2	105·0
14	103·8	105·4	101·0	103·0	104·6	106·0	101·4	103·0	103·6	103·8	104·0	105·6	106·0	106·8
15	105·2	106·2	102·6	103·0	105·6	105·2	102·6	104·0	103·2	104·8	105·0	105·6	107·0	107·0
16	104·2	106·8	104·8	106·0	105·6	106·0	105·0	105·2	104·4	105·0	105·0	106·2	108·0	108·4
17	106·2	106·4	106·2	106·2	106·0	106·2	105·0	105·6	104·6	106·0	106·0	105·4	108·2	107·2
18	105·6	106·4	105·6	105·4	105·0	105·0	106·0	105·2	106·6	106·6	106·6	106·2	107·0	106·6
19	104·0		105·8	106·6	102·4	104·0	104·2	103·4	105·4	105·4	105·6	107·0	106·0	106·6
20			106·2	107·4	103·0	104·0	102·0	102·6	104·2	105·4	106·0	107·0	105·0	106·2
21			107·0	107·2	103·8	104·4	101·0	104·0	103·0	103·8	105·6	106·0	105·0	106·0
22			106·8	107·6	105·4	107·2	104·4	106·4	102·6	103·0	105·6	106·0	105·6	106·0
23			105·2	106·2	106·0	107·0	106·0	106·0	101·8	102·6	106·2	107·0	105·0	105·6
24			105·2	105·8	105·6	104·4	106·0	106·8	101·2	102·0	106·8	106·0	105·0	104·4
25			105·2	106·2			106·4	107·0	101·2	101·0			106·2	107·0
26			103·4				106·6	107·0	100·0	101·6			106·8	108·0
27							106·4	107·2	101·2	102·0			107·8	108·0
28							106·0	106·4	101·0	101·2			107·4	107·0
29							106·0	106·0	101·2	101·2			104·0	
30							104·0		101·2	102·0				
31									101·4	102·2				

HEARTWATER INVESTIGATIONS.

As in previous reports the experiments conducted in relation to this disease are presented under subheadings. It will be noticed that none of the lines of investigation are new. In the course of the season's work, the pathogenicy of nymphal Bont ticks which as larvæ fed on heartwater sick animals was demonstrated by the infection and death of seven more goats. So thoroughly established now is the fact that the tick transmits the disease from stage to stage in its life cycle in this way that detailed mention of these cases would be superfluous, and the details are therefore omitted.

CATTLE ARE SUBJECT TO HEARTWATER.—Two cases in addition to those noticed in previous reports bearing out the statement that cattle are subject to heartwater have to be reported. The first is interesting in that it shows the disease may be very severe in a young ox ; the second in that it may be very mild.

Ox 26. Young, locally bred bull. Leg infested January 20th, 1904, with 27 *Amblyomma hebraeum* nymphs off heartwater sick Persian sheep No. 157. At least nine attached. Fever appeared February 2nd, and from then up to the 14th when death occurred the temperature readings ranged from 105·6° to 107·0°. Two goats were inoculated during the course of the fever to prove the disease really heartwater, and both of these succumbed in due time.

Ox 19. A locally bred bull, about two years old. Infested July 11th, 1904, with about 50 *Amblyomma hebraeum* nymphs off heartwater-sick goat No. 174 on January 13th. 16 attached. Fever appeared August 4th and continued for nine days during which the temperature ranged from 102·0° to 103·6°. At no time was there indication of distress. The animal is still alive. A sheep (No. 144) inoculated on August 18th, one week after the subsidence of the fever, reacted strongly, but survived ; whilst a goat inoculated from this sheep died at the proper time with typical lesions.

It is worth noting that a Persian sheep infected with ticks of the same batch as those applied to Ox 26 survived its attack. A record of the temperature readings of the ox for the whole of the inoculation and fever periods is given in the table published with the article on "Persian Sheep and Heartwater" in the August issue of the *Agricultural Journal*. It is also worth noticing that the ticks which caused so very mild

a fever in Ox 19 were of a lot from which specimens were taken to infest six goats and that every one of the goats sickened and died.

HORSES ARE IMMUNE TO HEARTWATER.—A test which appeared to show that the horse is not subject to heartwater was reported on page 28 of my annual report for 1902. The following tests lead me to conclude that the horse is naturally immune.

Horse 3. Animal about fifteen years old, procured locally, but early history unknown. Leg infested March 31st with 100 *Amblyomma hebraeum* nymphs off heartwater-sick Goat No. 174. Attachment heavy; 35 actually recovered after feeding and many later destroyed by washing leg with paraffin. No temperature reaction. Blood drawn on April 25th and passed intravenously into Goat 210 without producing a reaction; and the goat later proved susceptible by its death through infection transmitted by specimens from same batch of ticks from which those applied to the horse were taken.

Horse 5. Locally bred foal only a few months old. Leg infested April 19th with 100 *A. hebraeum* nymphs off Goat 174 in heartwater fever. Practically all attached, but leg washed with paraffin on fourth day before any fell because of restlessness on part of animal and fear that ticks would be scattered. No temperature reaction. Blood drawn May 15th, the 25th day, and Goat 220 inoculated intravenously with 20 c.c. Infection failed to result, and the animal was proved susceptible by inoculating some months later with 10 c.c. from a heartwater case; it then sickened and died.

THE BLUE TICK IS NON-PATHOGENIC.—By "Blue Tick" is meant *Rhipicephalus* (*Boophilus*) *decoloratus*. This remark is necessary because of the widespread occurrence in the Colony of two other species of *Rhipicephalus* of the *Boophilus* group. One of these, probably the *australis* of other countries, closely resembles *decoloratus*. A number of tests to determine if this Blue Tick acts as a transmitter of heartwater, all of which resulted negatively, were made in 1901 and 1902 and were recorded in the annual reports for those years. The Blue Tick goes on to its host as a larva or seed-tick to stay there until as a male it is exhausted and ready to die, or as a female is replete with blood. Consequently if the species were a factor in heartwater transmission, the infection would have to pass through the egg stage and be transmitted by the progeny of the individuals which acquired it from the animal. The females take three weeks or more to

arrive at full growth and to get specimens fed on heartwater blood has been found a difficult task. Many times heavily infested animals were given the disease only to die before the ticks were ready to come off or so soon after the fever had appeared that one was not justified in assuming that the ticks had imbibed infected blood. Ox 26, above mentioned, was a notable exception. and towards the end of its long and severe fever a large number of engorged females were secured which must have fed entirely on infective blood throughout their adult stage. These ticks were taken from the ox during early February and the eggs laid by them hatched in late March. As hot summer weather prevails at that time of year, there was no lack of warmth to develop infection in the ticks. Altogether, the conditions were so favourable for the testing of the progeny that there seems no reason not to accept the results obtained in the following experiments as decisive.

Goat 203. Locally bred Afrikander kapater. Infested March 28th very heavily with progeny of *Rhipicephalus decoloratus* females taken from Ox 26 after ten days of heartwater fever. The ticks attached all over the body and in such enormous numbers that the goat evinced great distress and lost flesh rapidly. From the fourth day onwards its temperature was very irregular and abnormally high, direct effects of attack by large numbers of ticks often experienced. The ticks were left unmolested until they began to fall on April 19th, by which time the entire surface of the body was closely studded with them. The suffering animal had become almost too weak to stand and, as it was no longer needful to consider the ticks, the body was sprayed with an arsenical dip to destroy them and thus allay the irritation. The relief came too late, the animal dying on the following night. No indication of heartwater was found at the *post mortem* examination, and the absence of infection was affirmed by the negative result of an inoculation, made April 18th, of 10 c.c. of blood intravenously into Goat 209.

Ox 15. Locally bred heifer, between eighteen months and two years old. Infested June 17th very heavily with progeny of *R. decoloratus* females taken from Ox 26 on the ninth day of heartwater fever. The attachment was excellent, and on the sixteenth day the body was sprayed with arsenical dips to prevent unnecessary suffering. No abnormal temperatures were recorded, and it was therefore considered unnecessary to inoculate from the animal to prove the absence of heartwater.

Ox 30. Locally bred bull about one year old. Infested May 20th, very heavily, with progeny of *R. decoloratus* females off Ox 26 on the tenth day of its fever. The attachment was excellent and thousands of the ticks were moulting to the adult state or had already

moulted and attached again when the skin was sprayed on June 4th. Notwithstanding the spraying some ticks completed their growth No abnormal temperatures observed.

Ox 34. Locally bred bull about one year old. Infested May 20th, the same as Ox 30, and a very heavy stand secured. Sprayed June 4th but not with much success, as some hundreds of females fed to repletion. No abnormal temperatures observed.

PERSIAN SHEEP AND HEARTWATER.—An instructive series of experiments to determine the behaviour of the Persian breed of sheep to heartwater was conducted during 1903, and the period now under review, by the writer in conjunction with Mr. Robertson. A joint article on this work was published in the *Agricultural Journal* for August, 1904; it embraces a record of the experiments with a brief description and history of the breed, an account of its introduction into South Africa, and a discussion of the remarkable resistance to heartwater which practical experience and our experiments prove it to possess.

The experiments clearly show that Persian sheep, as we now know the breed in South Africa, are susceptible to heartwater. They take the disease readily when exposed to infection, but recover without serious illness and thereafter possess a high degree of immunity. The virulence of the disease does not appear to be modified by passing through them, ticks which drop from them just after their fever reaction to infection being fully as capable of inducing fatal reactions in ordinary sheep, goats and cattle, as similar ticks from fatal cases of heartwater. The susceptibility and at the same time the resistance of the breed to the disease is such that a strain of infection may be passed successively by inoculation through sheep after sheep without any escaping a temperature reaction or suffering prostration, yet without causing apparent diminution in virulence of the strain for other animals.

All the animals used in the experiments were procured in the south-western districts, a part of the Colony far removed from the heartwater-infected area, and all are believed to have been locally bred. The tick infections were made by applying a limited number of specimens to an ear or leg under the shelter

of a calico covering; and the inoculations by injecting into the jugular vein the amount of freshly drawn blood indicated for each animal.

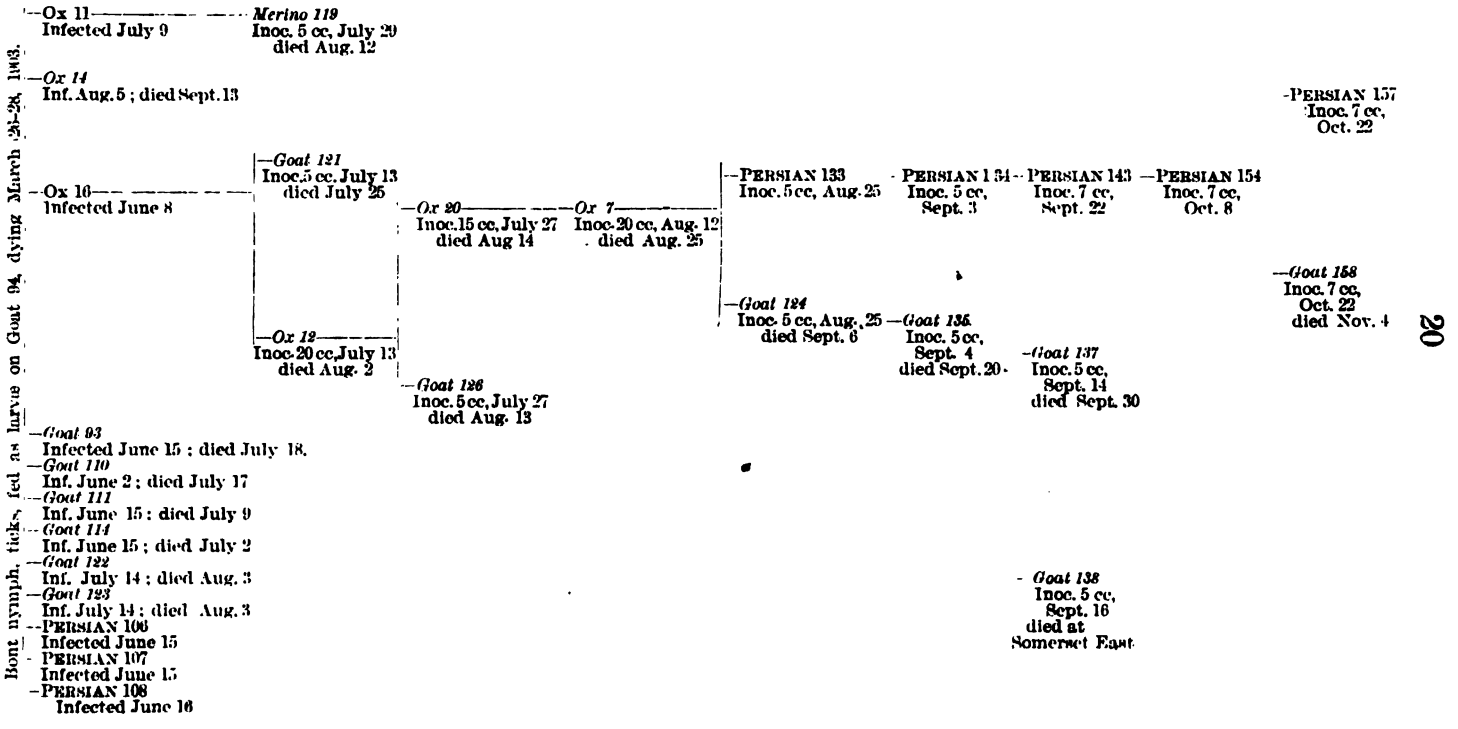
The Persian sheep used were all wethers and were procured from two sources. The first half dozen, Nos. 106, 107, 108, 120, 133 and 134, were kindly purchased for the work by Mr. A. G. H. Teubes, of Robertson, who got them from a local farmer. These sheep were remarkably uniform in size and markings, and had very small thin tails set askew from the enlarged rump. Dr. Hutcheon judged them to be six-eighths or more pure Persian. Mr. Teubes, when later asked to kindly enquire the history of the flock from which they came, wrote:

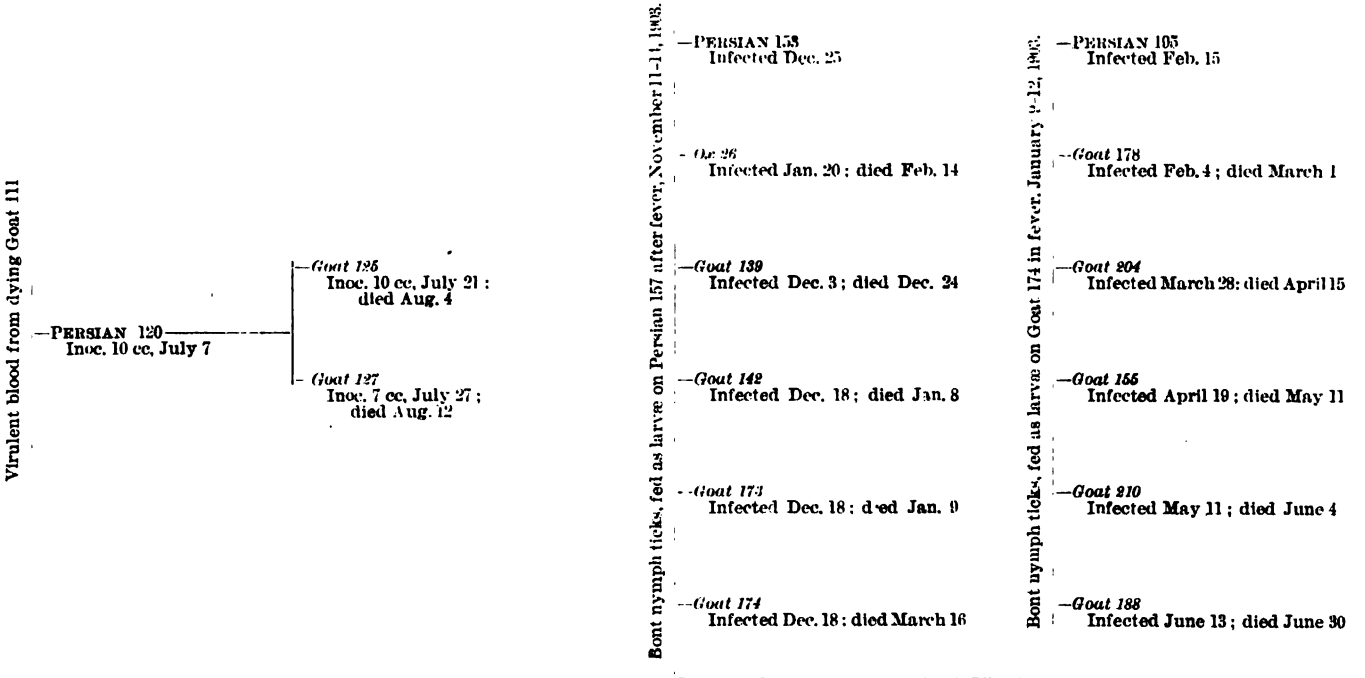
> "Mr. Van der Vyver says his first flock some years ago consisted of a cross between the original Afrikander and the Merino sheep. Upon the importation of the Persian by the late Mr. Chas. Barry, he started crossing these Bastards with the Persian, and he has ever since continued introducing new Persian blood. He thinks Dr. Hutcheon is fairly near the mark in saying that the flock is now about three-fourths pure."

The balance of the sheep, Nos. 143, 153, 144, 157, and 195, came from a flock in the neighbouring district of Worcester. They may have been likewise about six-eighths pure Persian, but they were less uniform in the markings of the body and in the size and shape of the tail than were the first. Two of them had quite tapering tails, but all had the characteristic fat rump, long slim legs, and coarse hair,—black on the head and white on the body. In height all the Persians stood about the same as the average merino.

A study of the accompanying diagrams will serve to explain the nature, and scope and detail of the tests conducted better than a volume of text matter. The first tests were with Bont Tick nymphs that fell as larvæ from dying goat No. 94 in late March, 1903. These ticks were used to infest Persian sheep Nos. 106, 107 and 108 in the middle of June, and all three reacted:—

Diagrams to show Source and Transmission of Heartwater Infection in Experiments with Persian Sheep.




Virulent blood from dying Goat 111
—PERSIAN 120
Inoc. 10 cc, July 7
—Goat 125
Inoc. 10 cc, July 21 : died Aug. 4
—Goat 127
Inoc. 7 cc, July 27 ; died Aug. 12
Bont nymph ticks, fed as larvæ on Persian 157 after fever, November 11-14, 1903.
—PERSIAN 153
Infected Dec. 25
—Goat 126
Infected Jan. 20 ; died Feb. 14
—Goat 139
Infected Dec. 3 ; died Dec. 24
—Goat 142
Infected Dec. 18 ; died Jan. 8
—Goat 173
Infected Dec. 18 ; died Jan. 9
—Goat 174
Infected Dec. 18 ; died March 16
Bont nymph ticks, fed as larvæ on Goat 174 in fever, January 9-12, 1903.
—PERSIAN 105
Infected Feb. 15
—Goat 178
Infected Feb. 4 ; died March 1
—Goat 204
Infected March 28; died April 15
—Goat 155
Infected April 19 ; died May 11
—Goat 210
Infected May 11 ; died June 4
—Goat 188
Infected June 13 ; died June 30

Transmission causing death marked in *Italics*. All the PERSIANS had fever, but none were prostrated. All the GOATS succumbed ; though No. 174, through careful nursing and heavy bleeding, survived for several weeks. Two tick infected OXEN died, and two survived ; and all three inoculated ones died.

152, was subjected to tests without any reaction at all being secured. Applications of ticks from Goat 174, known to be disease producing, were made December 25th, January 20th, and February 4th, and an inoculation of 15 c.c. of virulent blood on April 9th. The animal was one of the half dozen obtained in Worcester, and it seems barely possible that by some mistake it was confused with 143 or 154 of the same lot and that it has been on one of these, after its fever, that the negative tests have been made whilst the true No. 152 is with Mr. Spreull under a wrong number. A change from collar numbers to metal ear tags during the course of the period when all the animals were at the Experiment Station perhaps gave an opportunity for such a mistake; yet that a mistake did then or at any other time occur seems very improbable.

Several parties are now endeavouring to arrange for importations of Persian sheep, and if an opportunity can be found, a few of the animals bred oversea and the first of their pure bred progeny will be obtained for experiment. If the imported adults prove immune and the progeny only resistant, we will have good evidence that heartwater exists in the country in which the animals were reared, and incidentally an indication that the resistance is an hereditary acquirement. As experiments demonstrating resistance to the disease in the animals they import will be an excellent advertisement to the suitability of their stock for heartwater districts, we hope that importers will take the hint to gratuitously supply the Department with the necessary animals for such experiments. All animals that survived the tests, and we hope all would, could be returned. One firm of stock dealers has already promised to place a few animals, which they are obtaining in Persia, at our service.

TEMPERATURE RECORDS OF PERSIAN SHEEP INFECTED WITH HEARTWATER BY THE BONT TICK.

Days from Infection.	Persian 106.		Persian 107.		Persian 108.		Persian 153.		Persian 195.	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
		102·6		101·0		102·0		103·0		102·5
1	101·4	102·6	101·4	101·6	101·0	103·0	102·2	104·0	102·2	102·6
2	102·0	104·0	101·2	103·0	101·6	102·6	103·0	104·0	102·2	102·0
3	102·0	103·4	102·0	102·6	102·4	103·0	103·2	104·0	102·6	102·6
4	103·2	103·4	102·2	103·6	102·0	102·2	102·2	103·2	102·2	101·8
5	102·2	104·2	101·6	103·2	102·4	103·0	102·8	103·0	102·0	102·4
6	102·0	103·0	101·4	102·8	104·0	104·6	103·4	104·0	101·2	102·0
7	102·0	102·8	102·0	103·2	102·0	102·0	103·2	105·0	101·6	101·2
8	101·4	104·0	101·6	103·0	100·8	103·0	102·6	104·0	102·0	102·4
9	103·8	103·6	101·0	103·0	102·4	103·2	102·4	105·0	102·4	102·4
10	101·2	103·2	100·6	102·0	101·2	102·0	103·0	102·6	101·6	102·0
11	101·0	102·6	100·4	101·6	101·0	103·0	102·6	103·2	101·5	102·6
12	100·2	101·2	99·6	102·2	100·6	102·0	101·8	102·4	103·6	103·2
13	101·2	102·0	101·4	101·2	104·0	103·0	102·0	102·2	102·4	102·2
14	100·6	103·0	101·0	103·0	101·2	103·8	101·4	104·0	**104·4**	**103·6**
15	100·0	103·8	102·4	**104·6**	101·6	102·8	**103·0**	**104·8**	**105·0**	**104·6**
16	102·0	**105·4**	**104·0**	**105·4**	100·4	**104·6**	**105·0**	**106·2**	**104·4**	**103·0**
17	**103·0**	**105·4**	**105·6**	**107·0**	**103·4**	**105·0**	**106·0**	**105·6**	**103·0**	**102·6**
18	**106·0**	**107·6**	**107·2**	**107·2**	**105·0**	**105·4**	**104·6**	**105·2**	**105·4**	**105·4**
19	**107·0**	**106·6**	**107·0**	**105·2**	**106·0**	**106·0**	**106·0**	**105·8**	**104·0**	**105·4**
20	**105·0**	**105·2**	**104·4**	**104·0**	**105·6**	**106·0**	**104·6**	**105·0**	**104·0**	**102·4**
21	**103·6**	**104·2**	102·2	104·0	**103·6**	**105·4**	**104·4**	**106·0**	103·0	102·6
22	**103·2**	**104·0**	102·6	104 0	**104·0**	**104·6**	**104·8**	**104·2**	103·0	102·6
23	102·6	102·6	101·0	103·0	101·6	104·2	**103·6**	**103·2**	102·2	103·0
24	100·4	102·6	102·2	103·6	101·6	102·2	**102·6**	**105·0**	103·2	102·6
25	101·0	103·2	102·0	102·6	101·2	103·0	**104·0**	**102·4**	101·2	102·4
26	103·4	102·8	103·2	104·0	101·6	102·4	**102·8**	**103·4**	100·6	102·0
27	101·2	102·6	102·2	103·0	101·6	—	**102·0**	**105·0**	101·4	104·0
28	102·6	—	102·0	—	101·6	103·2	**106·0**	- -	101·0	101·5
29	101·6	101·0	102·0	104·0	102·2	103·2	**106·4**	**103·4**	101·0	102·4
30	102·2	103·2	103·4	103·0	102·2	104·0	102·2	103·0	102·0	102·0
31	102·0	104·0	102·0	102·0	102·2	104·0	102·0	102·2	102·6	103·0
32	102·0	103·4	102·0	103·0	103·0	103·0	102·0	103·0	101·0	102·0
33	102·2	103·0	103·0	102·2	102·0	103·2				

REPORT OF ASSISTANT ENTOMOLOGIST.

Including Special Reports on Mealie and Fruit Insects.

GENERAL STATEMENT.

My time during the six months ending June 30th, 1904, was spent in continuing the work briefly outlined in my report submitted January 11th, 1904. There was absolutely nothing available in the way of equipment till too late in the season to accomplish anything in the line of systematic life-history work. Through the good-will of the surrounding farmers and fruit-growers I was enabled to continue the field observations and from them outline practical tests for the coming season.

INSECTS AFFECTING MEALIES.

No one for a moment questions the important part which mealies play in the agriculture of the Eastern Province. On the other hand, very few appreciate the fact that the inauguration of a thorough study of how to grow and utilize the mealie crop to best advantage would mark the beginning of a new and brighter era for the Colonial farmer. Haphazard methods—to say nothing of neglect—are the greatest difficulties in the way of controlling the insect pests.

MEALIE STALK BORER (*Sesamia fusca* Hampson).—I use the term " Stalk Borer " in preference to "Grub" because it more nearly describes the habits of the larva and also prevents its being confused with " Cut-worms " which the farmers usually refer to as "Grubs." For obvious reasons, no attempt was made to determine the number of broods in a season. There is no evidence that this species passes the winter in any but the larval stage. It apparently does not attack any plants except mealies and Kafir corn. The larvæ

were found in abundance in the overwintered stalks from September to the middle of October, when they were pupating. The majority of the moths emerged during November: but five specimens collected September 11th, 1903, did not emerge as adults till December 9th to 22nd, 1903. The adults lived almost a fortnight when confined insmall pasteboard boxes. The eggs are laid in patches under the edges of the leaf-sheaths and hatch in about ten days. The larvæ soon make their way into the stem and feed there till the plant succumbs, and then migrate in search of fresh plants. Numerous young larvæ were found in young mealies four to six inches high on Mr. E. Estment's farm near Bathurst, October 23rd, 1903. The eggs must have been laid early in the month. In mealies over knee high at Martindale, November 12th, 1903, young to nearly full grown larvæ were found, and adults from this material emerged December 20th to 24th, 1903, thus overlapping with the last of the overwintered material from Graham's Town. I am inclined to the opinion that in the coastal belt there are probably three annual broods, provided young mealies are available for the first moths that appear.

The great irregularity in the appearance of the adults is accounted for by the fact that the overwintered larvæ are not all equally developed, some being scarcely three-fourths grown. With the return of warm weather the fully developed larvæ pupate, but the younger ones feed on the pith of the stalk. Retarded or stunted mealies remain slightly green throughout the winter, and hence the contained larvæ can feed without inconvenience when warm weather returns, thus prolonging the time during which moths appear. In mealie stalks of average size I find it to be the exception for a larva to penetrate to the root, *i.e.*, below the surface of the ground, and these seem to be the younger ones in search of food. The base of the stalk and the root remains succulent the longest, and hence furnishes the best food. In one field of small stunted mealies the larvæ had been driven by necessity to bore into the root and some had even gone through it but were still in communication with the stalk. If

the cobs are left on the stalks over winter, the larvæ often work into the pith of the cob and also into the kernels if they are soft on account of improper ripening. But there is a closely related species that also works in the cobs and hence there is a chance for confusion.

The irregularity in the emergence of the adults insures the infestation of late planted mealies. In one field planted about January 10th, 1904, the infestation amounted to nearly 10 per cent. by the first week in February. There is a distinct objection to late planting for it provides an attractive food supply at the close of the season and insures an abundance of hibernating larvæ. There is little hope of obtaining satisfactory results by trying to regulate the time of planting. The climatic conditions are so variable that a date which suits one farm will not do for another in a different situation even though not many miles away, and the farmers are too much inclined to plant whenever it pleases them. Hence there is almost sure to be a supply of young mealies ready for the earliest moths.

The thorough destruction of the mealie stalks by burning them root and all during the winter promises to be the most satisfactory way of dealing with the pest. Ploughing under will do some good, but on the whole will be unsatisfactory on account of the difficulty of getting the stalks thoroughly covered. It seems an easy matter to have a boy follow the plough, pull up the projecting stalks and place them flat in the furrow. The difficulty is that when you pull up one stalk you partly uncover another. Many of the stalks, though out of sight, are sufficiently near the surface to allow the moths to escape. If the ploughing could be done early the majority of the larvæ would perhaps perish before they could transform. A field ploughed the latter part of August was examined September 18th, 1903. The larvæ in the projecting stalks or those slightly covered were in good condition. Of four found in stalks that had been well covered, three were dead and the fourth was scarcely able to move. It is difficult to unearth the stalks so as to make

a satisfactory examination. Most farmers favour ploughing the stalks under with a view to improving the soil. But it must be remembered that adding so much coarse material augments the effect of drought. It would certainly be better to use the stalks for fodder and then return them as manure. Burning the stalks has the disadvantage of leaving the ashes in heaps which must be spread out or else the fields will become patchy. While removing and burning the stalks is thoroughly practicable, even under present conditions, systematic planting would greatly facilitate the work.

In view of the fact that the stalks, if harvested at the right time, are a very valuable portion of the crop, it is a pity to leave them to practically go to waste in the field. The silo is a simple and effectual means of preserving them as a splendid stock of food during the dry season. It would not be advisable to put the whole crop into the silo; but the remainder could be cut in time for fodder and the stalk borers destroyed in the process of shredding and feeding. Cutting the mealies for fodder will not be sufficient in itself, for I have found larvæ in perfect condition in fodder the latter part of June, *i.e.*, during the hibernating period.

There is no evidence to show how far the moths can travel: but I hope to get some indications from field tests planned for the coming season.

Two distinct species of hymenopterous parasites have been reared from the larvæ and a third from the pupæ. None of them have emerged from overwintered material. If this proves to be the rule on further investigation, the destruction of the stalks will have the further advantage of saving the natural enemies and their efforts will then be concentrated on the progeny of the few adults from larvæ that escape destruction. A dipterous larva has, on several occasions, been found feeding on dead or partly decayed stalk borers. It was at first thought that they were true parasites: but several of them were isolated on some of the decaying material from the infested plants and they developed without difficulty, evidently playing the part of scavengers. On several occasions larvæ were found

which had succumbed to a fungus disease and others to a bacterial disease. But since these diseases occur naturally and so much depends on the meteorological conditions, it was hardly worth while to spend time on them to the detriment of more urgent work. While the natural enemies are not strong enough to keep the pest under control they must not be overlooked in order that they may be shielded from needless destruction.

CUTWORMS OR "BLACK GRUBS."—The young mealie plants are often destroyed to such an extent that replanting is absolutely necessary in order to get a fair stand. Some prefer to plough the ground again and devote it to something else. There are several species common here, and the larvæ work throughout the year: but they are most destructive from the latter part of November to the middle of January. By making a clean sweep of the stalk borer during the winter the mealies may be planted as early as possible. The plants will then be large enough to offer the least attraction for the cutworms and will be less easily damaged. Late planting has the decided objection of having the mealies up in nice condition for the December and January broods of the cutworms. In certain late plantings under observation last season the farmer could not have succeeded better if he had deliberately planned to feed the worms. On small plantings the use of poisoned baits gives goods results, but where large fields must be controlled this method leaves much to be desired. The custom of planting the mealies in accordance with the rule "One for the grub and one for me" is decidedly pernicious. *Besides being inconsiderate*, the grub is unsystematic, and hence eats off the mealies in patches, thus leaving them too thin in some places and too thick in others. The final thinning then leaves a miserable stand to say the least.

Clean culture will do much to prevent the cutworms from becoming so abundant: but the moths will migrate from the great expanse of veld that cannot be controlled. Many of the farmers do not dare to resort to clean culture during the winter months for the wind would sweep away too much of

the soil. It will not be easy to arrange cover crops so that there will be no food for the worms.

If possible, practical field tests will be carried through on some of the farms during the coming season.

INSECTS AFFECTING FRUIT.

FRUIT MOTHS were not especially abundant in Graham's Town during the past season, and hence the work was confined mainly to chance observations and the collection of specimens with a view to getting some idea of the number of species concerned. Thirteen different species were found at work on fruit of different kinds. Some of the species were rather rare. *Serrodes inara* was the most abundant at Graham's Town. *Sphingomorpha chlorea* was by far the most abundant at Komgha and Kei Mouth. It is the only species that I found around lamps. Mr. H. G. Flanagan, Komgha, finds that bottles of sweets attract large numbers of the moths. How satisfactory this will prove to be remains to be demonstrated. Netting would certainly exclude the moths, and in view of the fact that it would also prevent injury from Fruit Fly, Fruit Beetles, Bats and Birds, there is much to recommend it. Judging from the number of species of moths concerned it will be no small task to fight them on the usual lines.

THE FRUIT FLY (*Ceratitis capitata*) has received considerable attention, and the detailed observations will soon be submitted for publication in the *Agricultural Journal*. They breed throughout the year in this locality provided suitable food is available. Adults can be found around the citrous trees throughout the winter and evidently are capable of waiting a long time if the fruit is not sufficiently ripe to serve as food for the maggots. A great many eggs are deposited in fruit that is too green, but they all perish as eggs or very young larvæ. The adults are keen feeders and take to any available sweet almost as soon as they emerge. Poisoned bait will be tried during the coming season. A small black hymenopterous parasite

has been reared from puparia sifted from the soil. It is very scarce and hence of little value in keeping the pest under control.

C. W. MALLY, M.Sc.,
Assistant Entomologist.

Grahamstown, October 10th, 1904.

PLANT IMPORTS FOR HALF YEAR ENDING JUNE 30TH, 1904.

Consignments.	Cape Town.		Port Elizabeth.		East London.		Mossel B.	
	cases.	tons.	cases.	tons.	cases.	tons.	cases.	tons.
Table Potatoes ...	3,234	135¼	1,600	29¾	10	¼	nil	
Seed Potatoes ...	6,234	248¾	5,339	198½	12,622	469	nil	
Onions	53	3	nil		500		nil	
Oranges	3,936		612		2		nil	
Lemons	1,010		576		616		nil	
Apples	3,099		101		302		nil	
Bananas	5,593		not kept		731		nil	
Pineapples ...	253		nil		nil		nil	
Other Fruits ...	165		8		43		nil	
Fruit Trees ...	65		nil		nil		nil	
Fruit Tree Stocks	14		1		4		nil	
Other Trees ...	7		nil		nil		nil	
Garden Plants ...	81		41		15½		nil	
Greenhouse Plants	18		44		8		nil	
Bulbs, Roots, etc.	29		74		12½		nil	

The potato imports totaled to 1,106½ tons of which 716¼ tons were seed tubers. Importations during the second half of the year are always heavier. Almost all the bananas came from Natal; the Port Elizabeth imports of this fruit are not kept. A few of the apples came from Canada in December and January. Nearly all this half year came from Tasmania and South Australia in May and June. The lemons and oranges come almost exclusively from the Mediterranean and arrived chiefly before March, when our citrous fruits are scarce.

PROCLAMATION

BY HIS EXCELLENCY THE HONOURABLE SIR WALTER FRANCIS HELY-HUTCHINSON.

Knight Grand Cross of the Most Distinguished Order of St. Michael and St. George, Governor and Commander-in-Chief of His Majesty's Colony of the Cape of Good Hope, and of the Territories and Dependencies thereof, etc., etc., etc.

UNDER and by virtue of the powers and authorities vested in me by Act No. 9 of 1876, intituled "Act to Regulate the Introduction into this Colony of Articles or Things which by reason of disease or otherwise might be injurious to the interests thereof," I do hereby proclaim, declare, and make known that, from and after the 1st day of September, 1904, effect shall be given to the Regulations set forth in the Schedule hereto for preventing and regulating the introduction into this Colony, by sea, from beyond the boundaries thereof, of the articles and things specified in the said Regulations.

Any person or persons contravening any of these said Regulations shall, on conviction, be liable to a fine not exceeding £100 sterling, and in default of payment thereof shall be liable to imprisonment for any term not exceeding six months, unless such fine be sooner paid;

And, under and by virtue of the powers and authorities vested in me by the aforesaid Act, and by the Vineyards Protection Act, 1886, I do hereby further proclaim, declare, and make known that, from and after the 1st day of September, 1904, Proclamation No. 96, bearing date the 20th day of March, 1903, and all Regulations prior thereto issued in this behalf, shall hereby be cancelled, revoked and made void.

GOD SAVE THE KING!

Given under my hand and the Public Seal of the Colony of the Cape of Good Hope, this 5th day of May, 1904.

WALTER HELY-HUTCHINSON,
Governor.

By Command of His Excellency the Governor in Coudcil,
ARTHUR J. FULLER.

No. 138, 1904.

SCHEDULE TO FOREGOING PROCLAMATION.

IMPORT REGULATIONS.

1. The introduction into this Colony of trees, plants and portions thereof, such as cuttings, roots, tubers and bulbs, and of fruit of all kinds, grown elsewhere than in South Africa is prohibited, save and except by sea, through the Ports of the Colony or by Post.

2. The importation of the following articles is hereby absolutely prohibited:—

(*a*) Grape vines or any portion or fruit of any grape vine, with the exception of vines or portions thereof imported by the Government under such precautionary measures as it may deem necessary.

(*b*) Coffee plants or any portion thereof, with the exception of seed.

(*c*) Eucalypt plants or any portion thereof, with the exception of seed.

(*d*) Coniferous plants or any portion thereof, with the exception of seed.

(*e*) Stone-fruit trees or any portion thereof, including seeds, that were grown or produced in any State, Province or Territory of the United States of America or the Dominion of Canada, or in any other country, in which either of the diseases known as Peach Yellows or Peach Rosette is found or reported to exist.

(*f*) Peach stocks and peach stones from any country whatsoever.

(*g*) Timber with the bark on, except scaffolding poles, shipped from the Baltic Sea or from Canada.

3. The importation of any tree or portion thereof, with the exception of fruit, seed, seedling stocks of fruit trees for budding or grafting purposes, and blight proof stock for apples, shall be allowed only by special permission from the Minister for Agriculture. No permit shall be granted for the introduction of more than ten trees or one hundred cuttings of any one variety, nor shall permits be issued for more than an aggregate of one hundred trees or one thousand cuttings to any party during one year. For the purposes of this clause the term "tree" shall include any plant of the nature of a tree excepting garden shrubs. In case of dispute as to whether any plant falls under this restriction, the decision of the Minister shall be final.

4. All trees, plants and portions thereof, such as cuttings, roots, tubers and bulbs, and fruit of all kinds and their packages, cases, pots or other coverings, shall, before being delivered to the consignees, undergo an examination by an officer appointed for that purpose to determine, as far as possible, whether or not insects or plant diseases are present; and it shall be the duty of the consignee or his duly appointed agent to open the coverings and to afford every facility to the examining officer during the examination.

5. All trees and woody plants, together with their coverings and packing material, shall as a precautionary measure against the introduction of injurious insects, be fumigated at the expense of the consignee in the manner prescribed by and to the satisfaction of the examining officer; and if the examining officer deems the treatment expedient, he may extend it to all other plants and all parts thereof.

6. Should any article, in the examination provided for in Clause 4, be actually found to be infested in whole or in part with any insect or plant disease, the introduction of which would be prejudicial to the interests of the Colony, it shall, together with all other articles in the same receptacle, with all covering and packing material, be cleansed or disinfected by the consignee, or at his expense, in the manner prescribed by and to the satisfaction of the examining officer; and if not so cleansed or disinfected, or if any treatment at command shall be deemed by the examining officer, or found by him, to be inefficient for the absolute eradication of the insect or disease, or if the examining officer knows the insect or disease to be of specially dangerous character, the articles shall be destroyed without delay.

7. Ordinarily, the inspection, and other treatment of consignments imposed by these Regulations, shall take place on the premises provided for the purpose by the Government at the port of entry; but special arrangements may be made with the Minister for Agriculture for the execution of all the provisions of Clauses 4, 5, and 6 on the premises of the consignee, when approved facilities, inclusive of a proper fumigation chamber, are there provided.

8. On the examining officer being satisfied with respect to a consignment that all the Regulations and conditions herein set forth have been fully complied with, he shall issue a certificate to that effect to the consignee: and before the issue of such certificate the consignment shall be under his control for the purposes of these Regulations.

9. Articles subject to examination under these Regulations introduced into this Colony by post shall be intercepted and examined by an officer

appointed for the purpose, and if found infected with any noxious insect or plant disease, shall be destroyed or cleansed at the discretion of such examining officer, and if requiring fumigation shall be so treated. All expenses of treatment shall be borne by the addressee.

10. The Government does not hold itself responsible for any loss or damage that may result from the destruction of articles under these Regulations, or from any process that may be considered necessary to cleanse or disinfect the articles, or to discover the existence or otherwise of any insect or plant disease.

11. These Regulations shall not apply to any consignment imported in bond for places beyond the borders of the Colony; nor to canned, dried or otherwise preserved articles in which there is no longer any plant life, with the exception of timber with the bark on.

CAPE OF GOOD HOPE.

REPORTS

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE YEAR 1904.

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

GOVERNMENT ENTOMOLOGIST

FOR THE

Half-Year ended 31st December, 1904.

Presented to both Houses of Parliament by command of His Excellency the Governor.

1906.

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TABLE OF CONTENTS.

PAGE.

General Statement 1
Staff of Office.

Publications 2
Articles in "Agricultural Journal."
"Remedies" Sheet.

Animal Diseases Investigation 2 3
Influence of Heat on Development of Heartwater.
Infection in the transmitting Tick.

Experiments with Tick-Destroying Dips 3 4
Efficacy of Arsenite of Soda.
Deterrent Effect of Arsenic.
Dangers in dipping Sheep.

Vine Diseases Investigation 4 5
Widespread Rumour of destructive new Disease.
Causes giving rise to apprehension.

Plant Import Regulations 5 8
New Restrictions.
Return of Plants and Fruits imported.
Analysis of Apple Imports.

REPORT OF EASTERN PROVINCE ENTOMOLOGIST.

Mealie Stalk Borer 9
Success of Cultural Remedy.

Fruit Fly 9 10
Unexplained temporary Disappearance.

Bathurst Beetle 10 11
Inefficiency of jarring Trees.
Apparent Success of Spraying.
Innocuousness of poisoned Beetles to Fowls.

Locust Destruction 11 12
Success with Traps.

Acknowledgments 12

CAPE OF GOOD HOPE.

DEPARTMENT OF AGRICULTURE.

Report of the Government Entomologist for the Half-Year ended 31st December, 1904.

Presented to both Houses of Parliament by Command of His Excellency the Governor.

1906.

THE HONOURABLE THE SECRETARY FOR AGRICULTURE.

In explanation of the form and brevity of this report in comparison with previous ones, I have to remark that instructions were received during the first half of 1904 that annual reports were in future to cover the financial year instead of the calendar year. In consequence my report for the first half of 1904 was submitted separately. However, when the time for the preparation of a report for the full year, July, 1904, to July, 1905, approached, instructions to revert to the old system were received; and a report for the second half of 1904 was requested so as to permit of the full year beginning with January, 1905. Subsequently, instructions have been issued to the effect that the shortage of funds this year necessitates that reports contain the minimum of elaboration. These circumstances, together with the general unsatisfactoriness of reporting on the progress of work for a period now long passed, have influenced me to entirely omit special reports and supplementtary papers such as have given length to previous reports.

STAFF.—The Staff of the Office during the period consisted of the Government Entomologist and the Assistant to Entomologist, Mr. R. W. Jack, with one clerk, stationed at Cape Town; and of the Eastern Province Entomologist, Mr. C. W. Mally, stationed at Grahamstown. A separate report by the last-named officer follows my own. I have had him pay special attention to mealie pests, and the results of his painstaking field work to demonstrate that the stalk borer of this plant can be controlled by simple measures promise to prove

of great practical value. The Fruit Fly has also been made one of his special subjects; and during November he devoted most of his time to field work on locusts. Under my direction he also spent a few weeks making observations in connection with the obscure paralytic affection of sheep and goats, said to be caused by a tick.

PUBLICATIONS.—Articles, as below tabulated, were contributed during the period to the *Agricultural Journal*, the official publication of the Department. In addition, many unsigned notes and replies in answer to letters from correspondents were contributed. The only publication of consequence other than these was a tabulation of the principal insect and fungoid pests of fruit trees and vines with formulas and directions for the preparation of all the common insecticides and fungicides and notes in regard to pumps and spraying. All the information is given on one large sheet headed "Remedies for Orchard and Vineyard Pests," and on the reverse appears a full translation in Dutch. Eleven thousand copies were printed, and half the cost of publication was borne by the Western Province Board of Horticulture. Copies of the sheet and reprints of all the articles below listed are available for distribution :—

AGRICULTURAL JOURNAL CONTRIBUTIONS.

TITLE.	Form.	Issue.	Pages.
			Vol. xxv.
Persian Sheep and Heartwater	Report	August	175–186
Distribution of Coast Fever Ticks ..	Article	September	268–270
*Notes on the so-called Paralysis Tick ..	,,	,,	291–296
The Codling Moth: Life Cycle Notes ..	,,	October	401–406
Gall Worms in Roots of Plants ..	,,	,,	406–412
Fumigation for Scale Insects	,,	,,	432–435
External Parasites of Fowls	,,	November	548–552
*The Fruit Fly	,,	December	647–662

*By Eastern Province Entomologist.

ANIMAL DISEASES INVESTIGATION.—Part of my own time, and nearly all the time of my Assistant, Mr. R. W. Jack, was given to the continuance of the investigations, which have been in progress for several years, with the object of elucidating the association of ticks with animal diseases. The investigations are conducted conjointly with the Veterinary Branch at the Animal Diseases Experiment Station, Rosebank. In past reports, it has been the custom to give full information on the progress of the work and detailed data on all the experiments conducted during the period reviewed; but the evident unsatisfactoriness of thus reporting on incomplete work up to a date already ten months past leads me to reserve the records

for the present period for consideration with the results of the work during 1905. However, steady progress was made in the investigation of the transmission of African Coast Fever and Heartwater. The most significant discovery made in connection with the latter disease is that the transmitting tick (Bont Tick, *Amblyomma hebraeum*) is able to complete its transformations at a lower temperature than is necessary for the assumed development of the infection that it may be harbouring. Specimens kept in a cool room whilst undergoing their changes have failed to transmit the disease, whilst specimens, off the same animals at the same times, which were exposed to greater warmth, have transmitted it in a number of cases. Moreover, further tests with ticks recovered from sick animals and moulted in a cool room have shown that whilst they are innocuous if applied as they are, they become infective if warmed for a few days in an incubator. These results put us in a position to explain the erratic appearance and disappearance of the disease, occurrences which heretofore have seemed unintelligible, and have led some farmers to dispute the agency of the tick.

EXPERIMENTS WITH TICK-DESTROYING DIPS.—Comparatively little can be done in investigating the transmission of diseases during the colder months, and advantage was taken of the slackness of such work to use the facilities of the Station for comparative tests of substances that may be applied to animals to destroy ticks. A report on these experiments has since appeared in the *Agricultural Journal* (March, 1905). The high value of plain arsenite of soda as a tick destroyer was shown by experiments conducted in conjunction with Mr. L. J. Roberts at his farm in the Fort Beaufort district some years ago and reported upon in my annual report for 1899; and the main purpose of the present experiments was to ascertain whether or not the proprietary dips that have since appeared and come into general use possess any real advantages over this exceedingly cheap and well-known chemical. The results were what I anticipated, and they have since been confirmed by dipping tests on a large scale conducted by the Veterinary Branch on Mr. Roberts' farm. The plain arsenite of soda is as effective as the proprietary dips and as it costs only a small fraction as much its general adoption in place of them may be confidently expected. The impetus to cattle dipping due to the saving will be of great advantage to the country. Some of the most popular dips contain wood tar, and it was generally supposed that the tar was of great value by causing the arsenic of the preparation to adhere and thus for a time to deter the fresh attack of ticks. The experiments, however, showed that the deterrent effects of the plain arsenite were equal to those of a tar-containing dip. A further

test that indicates the non-advantage of the tar was made after the report on the main experiments was submitted and is included here to get the details recorded. Two animals, the most alike that we had in condition, length and fineness of hair, and other features, were selected. One was thoroughly sprayed with a solution of the arsenite, and the other equally thoroughly with the equivalent strength of the most advertised and popular of the tar-containing dips (Quibell's). On the following day, the animals were thrown and the hair from one square foot of the flank of each carefully clipped and submitted to the Government Analyst for determination of the quantity of arsenic present. Eleven days later the animals were again thrown and the hair from a square foot of the opposite flank taken from each. The analyses were made by Mr. J. Lewis, who has acquired much experience in analysing arsenical preparations. His results were as follows :—

	Ox sprayed with Arsenite.		Ox sprayed with Quibell's Dip.	
	After 1 day.	After 11 days.	After 1 day.	After 11 days.
	gr.	gr.	gr.	gr.
Weight of Hair	8.750	7.975	7.000	5.700
Arsenic found ..	.021	.011	.0165	.065
Arsenic to each gramme of Hair	.0024	.00137	.00235	.00114

It is to be observed that the amount of arsenic one day after the spraying was practically identical in the two samples, but that the amount remaining after twelve days was about one-sixth greater in the case of the arsenite-sprayed sample.

Another series of experiments showed the danger of frequently dipping sheep in arsenical preparations strong enough to be efficacious against ticks. In general the better in condition the sheep were, and the heavier their covering of wool, the sooner they appeared to suffer. The animals were certainly affected through the skin. Some died shortly after being dipped and without having lost wool. Others shed the wool from the belly, flanks and face, and developed ugly sores on the skin exposed.

VINE DISEASES INVESTIGATION.—From the middle of October to the middle of November nearly the whole of my time was devoted to the investigation of vine troubles. The necessity for the investigation was urged by a deputation of Stellenbosch vine growers, which waited upon the Minister on October 18th and which averred that a serious new disease had appeared. The alarm had originated a few days before at Vlottenberg when certain four-year-old plantations of grafted

vines on low-lying, sandy soil were observed by their owner to be making little new growth in contrast to younger plantations on similar soil. A neighbour whose attention was attracted found on returning to his own farm that many thousands of his older grafted vines, of other varieties on different American stocks and planted on soil of utterly different character, had also started into growth feebly and irregularly and in marked contrast to younger vines. The condition of other vineyards round about was then enquired into and in almost all on inspection the growth was found much less advanced than was normal for the date, and many vines were found to have failed to start or to have formed many weak shoots instead of a few strong ones. The trouble appeared to be most acute in grafted vines four years or more of age; and the ugly fear arose that a new disease, probably the obscure, quick spreading and highly destructive "California Vine Disease" had been introduced with American vines. In a few days the scare was prevalent throughout the south-western vine districts, and from all parts came rumours of dying vineyards. The Minister at once appointed a commission to investigate the matter. I was made one of the five members, and it also fell to me to act as secretary. About sixty farms were visited and, happily, the observations made utterly failed to substantiate the fears of the growers. On the contrary, the unsatisfactory conditions which gave rise to the fright were found to be due in nearly every case to disregard of one or more well recognised requirements of grafted vines; and the effects of these weakening influences appeared to have been greatly accentuated by abnormal weather conditions which prevailed as the vines started into growth. The requirements most commonly disregarded were sufficient drainage, proper initial preparation of the soil, the use of a stock suitable to the soil and to the scion, the necessity of cutting roots which form from the scion, and the necessity of giving the vines ample space and food to compensate them for their far heavier crops compared with ungrafted vines. The report of the Commission was published in the *Agricultural Journal* for December. The alarm subsided as the season advanced and soon disappeared entirely.

Plant Import Regulations.—The enforcement of the regulations to minimise the risk of introducing insect and fungoid pests with importations of trees, plants, fruits, etc., is under my direction. New restrictions came into force on September 1st. These require that special permission be obtained to introduce any trees, except certain fruit tree stocks, and limit the number that may be introduced. Permits are practically restricted to varieties new to the country. The chief value of the regulations as a whole lies in these restrictions and in the absolute prohibition of certain kinds of

trees and plants, and in the compulsory fumigation of all woody plants on arrival. The old system, that of trusting entirely to inspection and treatment if pests were found, was a very inefficient safeguard. The greatest element of weakness now is that most fruit tree stocks are freely admitted. There is far less risk of new pests coming with them than with trees ready for permanent planting, and they generally appear clean, yet they might easily be the channel of introducing many grave troubles. If I were sure that our nurserymen could do without them, I would at once recommend that, after due notice, further importations be stopped. The inspection of fruit results in the imports being relatively high class. Many consignments of Mediterranean citrous fruits still have to be fumigated because of the presence of scale insects; but it has been necessary to refuse landing permits only with respect to a few small consignments of Madeira apples. The systematic inspection of potatoes and onions has not appeared to serve any useful end, and with the close of the year has been discontinued. The following table shows the quantities of the different articles that were passed by the examining officers at the different ports :—

TREES, PLANTS, FRUITS, ETC., IMPORTED JULY TO DECEMBER, 1904.

	Capetown.		Port Elizabeth.		East London.		Mossel Bay.		Totals.	
	Packages	Tons	Packages	Tons	Packages	Tons	Packages	Tons	Packages	Tons
Table Potatoes	27,735	1,052	3,959	137	4,274	140¼	...	...	35,968	1,329¼
Seed Potatoes	32,737	1,193	18,297	616	52,522	2,480	650	21¾	104,206	4,310¾
Onions	2,587	...	1,567	...	821	...	...	...	4,975	...
Oranges	1,812	...	290	...	63	...	...	...	2,165	...
Lemons	542	...	152	...	15	...	...	...	709	...
Apples	16,337	...	1,050	...	1,091	...	...	...	18,478	...
Bananas	6,407	...	*	...	1,540	...	...	...	7,947	...
Pineapples	59	...	*	...	...	...	...	...	59	...
Other Fruits	750	...	21	...	42	...	...	...	813	...
Fruit Trees	6	...	3½	...	1½	...	...	...	11	...
Fruit Tree Stocks	21	...	9	...	...	...	...	...	30	...
Other Trees	2	...	21	...	...	...	...	...	23	...
Garden Plants	67	...	65½	...	3	...	...	...	135½	...
Greenhouse Plants...	18	...	24	...	6	...	...	...	48	...
Bulbs, Roots, etc.	30	...	59	...	10	...	...	...	99	...
Hop Plants	...	...	1	...	½	...	...	...	1½	...

* Data incomplete.

It may safely be assumed that practically all of the fruit is consumed in the Colony, and that chiefly in the ports where it is landed. Very little fruit known to be for the Transvaal markets was landed at the Cape ports. The quantity of apples introduced is sure to excite comment on the part of fruit growers. Therefore, I venture to express the opinion that the introduction is attended with very little risk of importing new pests. Had we not the Codling Moth and the Fruit Fly the case would be different. The heavy importations to Cape Town are chiefly due to the enterprise of two firms, both of which appear to do their utmost to comply with our request that their importations be restricted to superior classes of fruit. I believe much good will be indirectly derived by our fruit growers from a continuance of these importations. Fruit shops are enabled to keep up their sales throughout the year, and thus the retail channels for the disposal of locally-grown fruit are increased. Moreover, by having good fruit in variety always before it, the public will in time become disabused of the idea that fruit is a luxury and will tend to regard it as a daily necessity. Thus far there is little actual competition with Colonial-grown fruit. Locally-grown apples and also locally-grown oranges are off before heavy shipments of over-sea apples arrive, and the importers say that importations are not profitable until the sales of Cape apples practically cease. The following table shows the leading sources from which the imported apples were derived during the six months under review :—

Where said to have been grown.	Number of packages.
Madeira	9,210
Canada	4,875
Australasia	3,184
British Isles	862

The remaining few hundred cases came from America and Continental Europe. The size of the package was variable and hence the figures give only a rough idea. The average weight of the contents, however, may be safely estimated at fifty pounds. The Canadian packages average the largest as some of them are barrels holding about 125 pounds. Five-sixths of the fruit at least came from the northern hemisphere. By far the largest shipments arrived in November and December and were designed for the holiday trade ; and fully three-fourths arrived after October 1st, long before which time all Cape apples had disappeared from the shops.

CHAS. P. LOUNSBURY, B.Sc., F.E.S.,
Government Entomologist.

October 18th, 1905.

REPORT OF THE EASTERN PROVINCE ENTOMOLOGIST.

THE GOVERNMENT ENTOMOLOGIST.

I have to submit herewith my report for the period July 1st to December 31st, 1904.

Besides the usual routine work of the office and sundry observations on the life cycle of, and remedies for, different insect pests, special attention was paid to the Mealie Stalk Borer (*Sesamia fusca*, Hamp.), Fruit Fly (*Ceratitis capitata*, Wied.), Bathurst Beetle (*Malacosoma* sp.) and the destruction of locusts.

MEALIE STALK BORER.—In the report for the half-year ended June 30th, 1904, apparently feasible methods of controlling the Mealie Stalk Borer were pointed out. While they seemed plausible enough, it was evident at the outset that they would have little influence with the farmer until their value had been demonstrated by actual field tests. The farmers in the Collingham Valley—Messrs. Herbert Wallace, R. G. Hoole, W. H. Barnes, Stanley Dold and Mr. Glanville—kindly consented to co-operate in the matter, and all the mealie stalks in the valley were accordingly burned during August. The work was carried out under supervision so that any drawbacks in the work as well as possible sources of failure could be noted. No effort was spared to make the destruction as complete as possible. A full report as to details will be given at the close of the season. Thus far the indications are very favourable, the first brood being very scarce indeed—only a trace compared with fields where the stalks have not been burned.

FRUIT FLY.—Observations were continued through the winter and spring, and ample evidence was found to show that they breed throughout the year if suitable food is available. Citrus fruits are of the greatest importance because they provide the chief food-supply for the winter broods. Frosts such as we have here seem to have no effect on the adult. They could easily be found out of doors till the latter part of October. Since that date it has been almost impossible to find them, and the fruit-growers are rejoicing in the fact that this is not a "maggot year." A satisfactory explanation for this sudden disappearance has not been found. As usual it is easy to point to variations in temperature, rainfall, birds, lateness of fruit, etc., but to demonstrate the responsibility of any one or all of these factors is a different matter.

Additional specimens of the parasite were secured by sifting the soil for puparia under late varieties of peaches. Thus far parasites have only been obtained from puparia sifted from the

soil. In no case has a fruit fly emerged from the sifted material, indicating that none survive the winter as puparia in the soil.

The tests with poisoned bait outlined in the December number of the *Agricultural Journal* were started the first week in December. It is the intention to continue them throughout the season, for there is no telling how soon the fly will again be out in full force.

BATHURST BEETLE.—Through the kind co-operation of Mr. Clifford Dold, spraying experiments were commenced on his farm near Martindale, December 2nd, 1904, with a view to demonstrating whether or not the beetles could be kept under control by jarring them on to sheets early in the morning and fortifying the trees by means of an arsenical spray. The beetles drop very easily early in the morning and can be collected in quantity, but later in the day they fly very readily and keep coming in so rapidly from the surrounding veld that the trees soon become covered again and other means must be resorted to. Of course, every beetle jarred off and killed helps that much and that part of the work should not be slighted: but the spraying was clearly of primary importance. The fact that the beetles come on rather suddenly and in very large numbers makes it important that the poison be used very strong so that they will quickly get a fatal amount of it, otherwise the foliage will be destroyed the same as if unsprayed. Arsenate of lead was selected as the posion most likely to give best results because of the fact that it can be used very strong without endangering the foliage.

The beetles had been at work for some time before the spraying could be arranged for, and hence the trees were already badly damaged. The orchard, consisting entirely of young trees, was divided into two parts, and the one part sprayed with arsenate of lead one pound to twenty-five gallons of water and the other with two pounds to twenty-five gallons of water. A large number of beetles was collected and isolated on branches taken from trees sprayed with each strength. Those from trees sprayed with the stronger solution were dying by the second day and all had succumbed by the fourth day. The weaker solution required several days longer. The Manager reported that he "could find no dead beetles, but they all disappeared in a few days." Two other farmers sprayed with the weaker solution. They also were conservative about saying that the beetles had been killed because they could not find the dead ones, but both reported that "the beetles disappeared in a few days." Their disappearance and the failure to find them is no doubt due to their scattering out as soon as they feel the effect of the poison and creeping away into crevices, under clods or into the grass, so that it would take very close work to find them. In one case where a strong

spray of Cooper's Dip had been used dead beetles were abundant under the trees. This is due to the much greater amount of arsenic in the quantity of dip used. Unfortunately the trees were as completely scorched as if they had been swept by fire.

The difficulty in finding the dead beetles should be reassuring to those who fear that poultry will be poisoned by picking up the dead beetles. To test the effect of the dead beetles on poultry, those which died in the cages were carefully counted (1,485 from the stronger and 875 from the weaker spray, making a total of 2,360), mixed with flour, moistened with water and made into pellets of convenient size. A fowl was then crammed with the lot at one time and replaced in the run. No trace of injury was noticeable at any time. There seems absolutely no danger of fowls being killed by picking up the beetles dead from poison.

Where trees loaded with fruit are sprayed the fruit should be thoroughly washed as a precaution before using it.

Locust Destruction.—The Brown Locust (*Pachytylus sulcicollis*) appeared in abundance in certain districts during November, and there was the usual spasmodic effort to "do something." Many conflicting reports were received in regard to the effectiveness of blue mottled soap and a number of complaints of the inadequacy of the pumps supplied by Government. In accordance with instructions from the Government Entomologist work was undertaken to determine the comparative value of different soaps and patent sheep dips which had often been reported as giving satisfactory results. The co-operation of the Whittlesea Farmers' Association (near Queenstown) was secured and the tests made about the middle of December. The results are being prepared for publication in the *Agricultural Journal* and hence the details need not be given here. Suffice it to say that with care in regard to weights and measures and, above all, with thoroughness in the application of the soap solution, good work can be done, and the Success pump is not at fault when used within the limit of its possibilities.

The time at my disposal was too limited to carry on tests with the poisoned bait which has given such good results in Natal. Besides, the locusts were beginning to transform to the winged stage.

Trapping was tried with considerable success. Good work may be done in this way by catching the large swarms of "voetgangers" that come on suddenly, thus protecting the lands and saving the locusts as a byproduct of commercial value. Judging from the demand for dried locusts as poultry or ostrich food, they would no doubt command a price in the market which would considerably reduce the cost of trapping

them. The chief objection to the trap used thus far is that the whole swarm must pass through a space two feet wide. It does not seem a difficult task to invent a more workable trap, but I shall refrain from making suggestions at this time, in the hope that different ones who are interested will work out a trap on original lines so that we may choose the best.

ACKNOWLEDGMENTS.—The Albany Museum Committee, through their President, Dr. H. Becker, and the Director of the Museum, Dr. S. Schönland, continue to co-operate in every way possible to further the interests of the work of this Office, and I wish to express my appreciation of their kindness.

The Government Analyst, Mr. J. Muller, has frequently been consulted on questions relating to insecticides, and I sincerely appreciate the courteous and helpful manner in which he has always responded.

The farmers and fruit-growers have also co-operated most heartily whenever occasion offered, thereby making it possible to continue work which otherwise would have been impossible, and I thank them for their abiding interest in the work.

C. W. MALLY, M.Sc.,
Eastern Province Entomologist.

October 3rd, 1905.

REPORT of the Governmen

Year 19

REPORT OF THE GOVERNMENT ENTO

Detailed reports on special features of t
ports for previous years have chiefly consist
report, in accordance with the recent genera
that their annual reports should contain mere
intimation that all detailed information a
through the medium of the *Agricultural Jo*
of the Department.

The work of the Branch for the year m
headings:—

1. Investigations of the transmission of
2. Investigation of natural enemies of
3. Investigation of mealie stalk borer.
4. Experiments and demonstrations in
5. Experimental tests of insecticides.
6. Supervision of plant and fruit impor
7. Supervision of nursery inspection re
8. Miscellaneous work, including the o
   nection with injurious insects and
9. Correspondence and publications.

for instances); and that it remains ready for
they are ready to feed again after they have
ach infection. It illustrates that the infection
resistant to re-infection. The table on the
of the survivors suffered much disturbance in
n the course of the experiments, and of them
on susceptible cattle. Altogether thirty-three
k beast, then as nymphs on a goat or other
has every attempt to secure infection through
ones. Every attempt to secure infection from
have been produced have been communicated

that tick destruction by dipping and spray-

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arate report for the Eastern Province Entomologist will be submitted Mr. Mally prepared a report as usual, but owing to the instruction that illustrations must be omitted not having been issued in time, the docu- lengthy for inclusion. Its essential features will be published in the *Journal*.

PONDENCE AND PUBLICATIONS.—Considerable time is expended in reply- iries concerning injurious insects from residents in every part of the e service is, of course, gratuitously rendered. By having a supply of or more reprints of *Agricultural Journal* and other articles to draw upon, generally able to supplement the information it is practicable to give by y particular subject by printed accounts. Articles, as below tabulated, uted during the year to the *Agricultural Journal*. Reprints of most of ailable for tabulation. The articles preceded by an asterisk were con- the Eastern Province Entomologist. He also published a number of rticles on insect pests in rural newspapers, notably the *Midland News*. one entitled "Transmission of certain Diseases by Ticks," and the other l Peculiarities of some South African Ticks," were read by the writer ritish Association meeting held at Cape Town in August. These record rm the chief results of the studies on ticks, and their connection with t have been conducted by this Branch of the Department. They may by the Association: if they are not, arrangements will be made to pub- sewhere in order to have copies available for those interested in this

AGRICULTURAL JOURNAL CONTRIBUTIONS.

Title.	Issue.	Pages.
		Vol. xxvi.
mies of the Fruit Fly	January ...	84–87
stances for Tick Destruction	March ...	387–395
tion of Locusts	,, ...	406–420
		Vol. xxvii.
Stalk Borer	August ...	159–168
of the Apple and Pear...	,, ...	160–174
e in Argentina	,, ...	192–210
mies of the Fruit Fly: Report ...	September...	309–319
,, ,, ...	October ...	457–469

ISSION OF DISEASES BY TICKS.—The chief work along this line of investi- rith African Coast Fever, and was in direct continuation of the previous s. When the year opened our experiments had only shown one species Brown Tick, *Rhipicephalus appendiculatus*, Neumann, to be concerned mission of the disease, though a single case by Dr. A. Theiler, of the gricultural Department, had implicated another species, *Rh. simus*, C. L. our subsequent experiments it has been demonstrated that five species capable of communicating the infection. These all belong to a section *Rhipicephalus*, which Professor G. Neumann, who is monographing the oses to distinguish by the name *Eurhipicephalus*. The five are the two ed and *Rh. nitens*, Neumann, *Rh. evertsi*, Neumann, and *Rh. capensis*, last three of these are common in the southern and south-western ny, and so generally distributed in one or another of the five f the Colony where ticks are common on cattle can be considered

nsmissions by various Species of Ticks.

Stage of Fever.	Artifically Incubated.	Number Applied.	Number Attached.	Date Applied.	Days' duration of Incubation.	Days' duration of Fever.
Death	Not	7	3	Nov. 27, '02 ...	15	13
,, ...	,, ...	Many	Many	Apr. 8 (?), '03 ...	...	15
Dying	,, ...	14	6	Jan. 3, '04 ...	13	6
,, ...	,, ...	12	9	Jan. 5, '04 ...	16	10
,, ...	,, ...	12	9	Jan. 12, '04 ...	12	12
,, ...	,, ...	2	2	Jan. 26, '04 ...	16	9*
,, ...	,, ...	1	1	Jan. 26, 04 ...	13	
,, ...	,, ...	3	5	Mch. 11, '04 ...	12	12
,, ...	,, ...	7	5	Mch. 28, '04 ...	12	17
Death	Moulted ...	6	5	Oct. 22, '04 ...	16	17
,, ...	,, ...	5	4	Nov. 10, '04 ...	19	16
10th-13th day.	Not ...	21	...	Dec. 20, '04 ...	15	16
8th day ...	Moulted ...	15	4	Jan. 6, '05 ...	12	14
,, ...	,, ...	15	15	June 23, '05 ...	13	12
,, ...	,, ...	6	4	Aug. 26, '05 ...	18	6
,, ...	,, ...	7	3	Sept. 20, '05 ...	20	15

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r when we were looking for it, and the preva-
Mr. Compere has vastly over-estimated its im-
Mr. Compere's faith in it is still unshaken:
Bahia and succeeded in collecting fresh sup-
middle of November, when he last wrote, Mr.
this insect. It is not an enemy of the Fruit
value in properly-cared-for orchards, since,
eeks Fruit Fly maggots in fruits which is on

e Codling Moth parasite found in Spain by
into California a year ago. The parasite is
learn from the United States Entomologist,
eneral European distribution. As the Codling

e ticks are not fed. Animal 60 was infected on the last day of Novem-
which had fallen from an ox on February 17th. A detailed account of
iments, negative as well as positive, was prepared for inclusion with
ut owing to the recent instructions alluded to in the first paragraph the
f this account is postponed.

Enemies of Injurious Insects.—Four months of the writer's time,
day, were spent on an expedition to Brazil to investigate alleged efficient
ies of the Fruit Fly, *Ceratitis capitata*. A lengthy account of the in-
nd of the causes which led up to it is given in the *Agricultural Journal*
r and October. The West Australian Entomologist, Mr. George Com-
ited Brazil the year before, and had reported in most positive terms
t Fly was present, but was not a pest, it being kept in suppression along
ecies of fruit flies by certain hymenopterous parasites and a Staphylinid
after discounting heavily for superficial observation and the excessive
a natural enemy enthusiast, there still seemed so great a chance that
had made a discovery of deep importance to South African horticulture
er felt no hesitancy in urging the Government to conduct an immediate
. Mr. Claude Fuller, the Natal Entomologist, accompanied me to
our expenses were shared by the Cape, Natal, Transvaal, and Orange
es. After initial studies at Bahia, which from Mr. Compere's report
the most favourable locality to visit, the writer proceeded to Rio de
tos, Sao Paulo, Campinas, Petropolis, and other Brazilian places, and
ed to the Cape, *via* Montevideo and Buenos Ayres. So far as confirm-
pere's conclusions in regard to the status of the Fruit Fly is concerned,
n was a total failure. In the parts of Brazil visited fruit flies, far from
suppression by natural enemies, are pests of the most positive charac-
capitata was not observed at Bahia, but another species infested most
s, pitombas and pitangas. The climatic conditions are too unfavourable
the peach being grown in that vicinity, but about Sao Paulo and Petro-
e grows luxuriantly, and there *the* Fruit Fly was found in abundance.
nquiries admitted of only one conclusion,—and that was that a locally-
fruit without maggots was a rarity. Most of the peaches, it was com-
l, became maggotty whilst still quite immature. Loquats, oranges,
ms, and the few pears and apples that are grown also suffer severely,
g to the allied pest, a good guava is one with only a few maggots or
s still too small to readily attract attention. Good pears, apples, and
said to be grown in one part of the State of Sao Paulo, a small table-
,000 feet in altitude, where heavy frosts are frequent in winter, but this
e country was not visited by Mr. Compere. To guard against any pos-
istake in the matter, arrangements were made with the Honourable the
Agriculture of the State of Sao Paulo for a competent official to make
on the prevalence of the Fruit Fly throughout the peach season,
March. The official, Mr. Adolph Hempel, who is entomologist and
gist of "Instituto Agronomico" at Campinas, has already thrown much
the problem. He has discovered that the Fruit Fly freely attacks
, and as coffee is the principal crop in Sao Paulo, it is small wonder that
hes get stung. The initial rearing from coffee consisted of fifty-three
hem *Ceratitis capitata*. Owing to the thinness of the pulp, one would
pect maggots in coffee berries to become readily parasitized if any para-
out, and the fact that not a single specimen of parasite emerged with the
s significant.

beetle described by Mr. Compere was nowhere observed, and
it at any of the museums. We came to the conclusion that

Moth is very destructive in most parts of Europ
some reason to doubt that the parasite will wor
growers may rest assured that should it prove no
lost in securing its introduction into South Afric
on the Codling Moth in the Colony. The more
been known for several years about Cape Town,
Stellenbosch. Mr. Mally reported that it was ve
1905, and thought it was destroying nearly half
though it has worked undisturbed in the aband
Newlands, where it was earliest observed, almost
pest this summer.

Efficient parasites for the Fruit Fly and C
absurd to reason that such *must* exist because in
importance in certain countries have been suppr
natural enemies introduced from other countrie
line is the subjugation of Black Scale (*Lecanium*
lista cyanea parasite of South Africa. The para
and after a number of failures and much arduo
ago, in getting to California specimens from wh
carried on. The Black Scale was the worst sca
being very troublesome in orange, lemon, olive
work of the little parasite is said to save annuall
ling. Of such importance is the matter conside
in his last message (December, 1904).

Mealie Stalk Borer.—This is the greatest
the Colony. The Eastern Province Entomologi
has found that it is practicable to control it by
illustrated by a coloured plate, was given in the
insect passes the winter in the old stalks and stu
ing of these waste portions of the plant before th
destruction. Mr. Mally arrived at this conclusio
of the insect; and he then set to work to prove
the co-operation of the owners of a group of far
ally supervised the uprooting and destruction of
the early spring. The results strongly suppor

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in to arrest the attention of fruit-growers, and
re information on these imports, the following
the quantities which have been landed at Cape
ut the same as a case, and a barrel about three
calculated as about 23,000 cases. The figures
. The importations from Australasia increased
remained about the same, while those from
No landing permit was refused in the case of
deira apples were less fortunate, and our action
cause of Codling Moth and Fusicladium pro-
f in importations from the island. The dealers
her consignments. Only the best of the three

months since other thousands have been watered, and each time the re-
n the same: in a week or two we had a host of young voetgangers. One
atched in December, 1905, and another is hatching at the present time,
0th, 1906. Hence it is now proved that in the absence of sufficient mois-
tch them, eggs of this species of locust will retain their vitality over
nths. It seems not at all unlikely that in this remarkable fact is the
ation for the enormous swarms of locusts which migrate from the desert
he north and north-west in seasons of good rains. The accumulated eggs
seasons must then hatch simultaneously. Presumably, during the pro-
p of the pest, the parasitic and predaceous enemies practically disappear,
t thus permitted to develop with little molestation when the favourable
ves.

AND FRUIT IMPORT REGULATIONS.—The writer is charged with supervis-
forcement of the regulations to minimise the risk of introducing insect
d pests with importations of trees, plants, fruits, etc. Importations are
p the ports of Cape Town, Mossel Bay, Port Elizabeth, and East London.
ntendent of Parks at Port Elizabeth examines consignments which arrive
t. At the other ports, the examiners are Customs officials; but at Cape
oody plants are seen by myself or an assistant. The regulations restrict
s of trees to small numbers, introduced by special permission, and their
alue is largely due to this restriction and to the total prohibition of cer-

It is impracticable to have the inspections at all the ports conducted by
lly conversant with insect and fungoid life, since there is too little work
ppointments for the duties alone, and since local men with the necessary
ns who could combine the work with other duties are not to be found.
ever, become very desirable that a trained officer take over the work at
, and I hope soon to arrange for an assistant from the office to be in daily
at the Docks for as many hours as may be necessary. The accompanying
hows the number of cases of trees, plants, fruit, etc., that were passed by
ers at the different ports. Potatoes, onions, pineapples, and bananas are
dinarily detained for examination, and for this reason they are not listed
rns.

ES, PLANTS, FRUITS, ETC., IMPORTED JANUARY TO DECEMBER, 1905.

	Cape Town.	Port Elizabeth.	East London.	Mossel Bay	Totals.
	Packages.	Packages.	Packages.	Packages.	Packages.
... ...	2,722	599	642	...	3,963
... ...	1,987	273	190	...	2,450
... ...	16,633	1,136	102	...	17,539
ts	4,494	105	58	...	4,657
s	8	3	3	...	14
s Stocks	21	17	...	...	38
s	1	...	2	...	3
nts	208	143	15	2	368
se Plants	60	7	1	...	68
ts, etc.	72	59	13	1	145
... ...	...	1	...	...	1

grades of apples sent from the island is good enou
liness. Some trouble was also experienced with
Kent being much infected with Fusicladium.
Canada were above criticism. Evidently the sea
regards Codling Moth and Fusicladium, and prol

The official grade marks, xxx and xxxx, an
about £1 5s. a barrel, c.i.f. Cape Town, showed t
for, but fruits spotted with Fusicladium or enter
in practically every barrel. One consignment of
Oyster Shell Bark Louse, and had to be fumigated
were dishonestly graded, small inferior apples be
The attention of the Canadian Government repre
affairs, and it is hoped that the steps which he p
petition of this year's troubles. If there is not
Canadian shippers may expect to lose the South
apples are imported chiefly for the Christmas trad
market when local apples appear. This year the
weeks later than was anticipated, and owing to
prices realised were very unsatisfactory. The d
prices for sound fruit dropped to 4d. a dozen in

IMPORTATION OF APPLES, CA

Month (1905.)	Australian Colonies.	Madeira.	British Isles	Ca
Janv. ...	200 cases	...	20 cases	900
Feb. ...	...	...	...	
March	...	...	...	
April ...	1,922 „	...	...	
May ...	705 „	...	...	
June ...	1,730 „	...	...	
July ...	1,565 „	...	...	
[redacted]	1,279 ...	193 bas...		

found it so inferior to arsenate of lead in important
mmend it where the latter, or even reliable Paris
has become the writer's practice to omit the
which occupy much of the time of himself and
nual reports, as there is little to justify allusion
account for time. The following subjects, how-
ise they are outside of the ordinary field of work.
orange growers of the Colony who wish to grow
e stock for their trees. Much trouble is experi-
-rot, and years ago the Government strongly re-
eville stock as a preventive. It was soon found,
poor growth or no growth at all on the Bitter

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next selling season, and the only special obligations meanwhile imposed
. to general nurseries is that fumigation chambers be provided in connec-
· them, and that all stock, not exempted by the inspector, be exposed therein
yanic acid gas before it is sent away.

Act is far from ideal for its purposes. The draft which the writer recom-
uffered many amendments after it left his hands, and emerged from Par-
·ith considerably altered details and the addition of some momentous pro-
Even the term "nursery" was tampered with; and the change makes it
to deal with florists' plants and vines on the same basis as nursery stock for
planting. The inspections to date have not disclosed any but well-known
but, as was feared, nearly all the nurseries are much infested with those
·e insects, Red Scale and Woolly Aphis. The condition of some nurseries
ely woeful. Already, however, the Act is bringing about vast improve-
ıd it is a pleasure to record that there is a general disposition to eagerly
remedies that are recommended. It is intended to apply the pressure of
radually, so as to give even the nurserymen who have been most negligent
opportunity to escape prohibition on the distribution of any of their stock;
ess, laxity will be carefully avoided, and the nurserymen who wait until all
sions are in force before they take resolute action to eradicate pests will find
·s seriously handicapped.

ING MOTH.—Special mention should be made of this destructive apple
pest. Ten years ago it was only known around Graaff-Reinet and on a few
Constantia and Stellenbosch. To have exterminated it even then was im-
e, but its spread over this country of widely separated farms could have been
·tarded by a prohibition on the transport and sale of infested fruit. No
ıeck it, however, was taken until very recently; and now the pest is so
d that the prohibition on the introduction of apples, pears, and quinces
in Eastern Districts is probably too late to appreciably benefit many of
he insect appears to be generally distributed throughout the Cape, Stellen-
arl, Tulbagh, Ceres, and part of Worcester Divisions, and over a wide area
aaff-Reinet, and is established at Prince Albert, Beaufort West, Cradock,
orth, and Uitenhage. It has also been found at Bloemfontein in the
nd at Middelburg in the Transvaal. As it generally escapes recognition
r or two after its introduction, it is probably in many other towns. Our
ppear to show that there are only two full broods in the year, but in our
ate adults of one or another of the broods are flying in numbers throughout
deciduous orchard trees are in fruit. The first to emerge in the spring lay
·s on plum trees, where plums stand amongst or near infested pears, the
n being still leafless whilst the plums are setting fruit. Apricots and
lso become infested to some extent, and occasionally the loss is material.
n one grower has determined to use an arsenical spray for his Japanese
xt season.

green has thus far been the arsenical commonly employed, but it is ex-
at arsenate of lead will be very popular next season, as one merchant pro-
but a leading American brand on the sale at about one-third the price now
Hitherto the price was against its adoption, and it was feared that stocks
eriorate if held over from year to year, owing to the moist condition of the
n. A very pronounced deterioration was found by use to occur in moist
en. But chemical analysis and practical tests have showed us that some
nate of lead which we had on hand in original glass pots for over five years
tly safe for use. The preparation mixes more readily with water than
er, keeps better in suspension, coats the tree more nearly uniformly,
, and can be used at much greater strength without danger to the
tried arsenite of soda with lime, a favourite Australian arsenical

Seville, and the Government was severely censur
office became interested, and undertook to learn
The information gathered showed that the stock w
generally satisfactory, but no explanation of its
Thereupon the writer compiled the accumulated
ment to undertake experimental tests of Bitter S
over-sea seeds in comparison with Rough Lemon
started at Elsenberg, under charge of Mr. F. T. B
the American representative of the Bitter Seville,
seeds of European types from the Mediterranean
leading commercial varieties were specially impo
periment for a year or more, Mr. Bioletti resigne
appointed, it became necessary for me to make
work. There was no Government institution to
Mr. H. G. Flanagan, of Prospect Farm, Komgha
baar, Wellington, the former in the extreme east
of the Colony, were prevailed on to accept it und
well-known fruit-growers, who have had nurser
number of trees in about a dozen different vari
Bitter Seville and other stocks.

Another matter to which attention is being
or Capri figs in the Colony with a view of int
Blastophaga grossorum. Here again we were co
ing no Departmental experiment station. Capri
with some true Smyrna figs of commerce, were im
years ago, divided into several lots, and each lot
ested party. Two lots went to farms in Consta
Elsenberg, in Stellenbosch, one to Wellington, a
at Grahamstown. The trees at Wellington and
them cuttings have been taken for a few other c
bearing regularly and heavily enough to justify
soon as they are no time will be lost. Parts of th
and it is not too much to hope that before many
will be fully supplied by Cape dried figs equal t

A third non-entomological matter to whic

ar Grahamstown, the damage to apples appears to have been slight. The ease (some authorities consider it identical) of pear trees has been known y-five to fifty years around Cape Town, but it rarely attracts attention, ex- he old variety called "Zoet Saffron." This year half a dozen or more were infected in some orchards, including William's Bon Chretien. It is ed that as the new orchards of the last named and some other choice varie- lder and more dense they will suffer appreciably from the trouble year after ıey are not protected by thorough spraying with a fungicide in the early The variety of apple reported to suffer most is the Late Bloomer. This is ıte, since the variety is the one most largely planted in the east. How- damage may not often be serious. One grower near Grahamstown recently t he had known the disease for fifteen years, and that he for one did not great loss from it. Until his attention was called to it this season he did not had to do with the dread "Black Spot."

CHAS. P. LOUNSBURY, B.Sc., F.E.S.,
Government Entomologist.

Town, February 14th, 1905.

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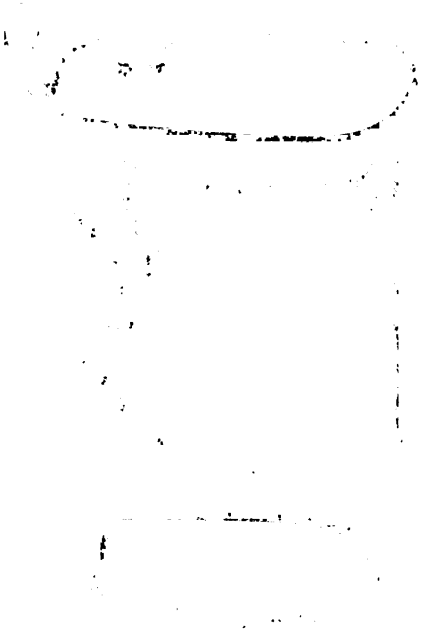
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